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07-AFC-5
DATE May 13 2009
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May 13, 2009
File No.: 04.02.16.02
Project No. 357891

Mr. John Kessler, Project Manager
California Energy Commission
Systems Assessment and Facilities Siting Division
1516 9th Street, MS 15
Sacramento, CA 95814-5504

RE: Data Response, Set 2H
Ivanpah Solar Electric Generating System (07-AFC-5)

Dear Mr. Kessler:

On behalf of Solar Partners I, LLC, Solar Partners II, LLC, Solar Partners IV, LLC, and Solar Partners VIII, LLC (Applicant), please find attached one original and four hard copies and five CD copies of Data Response, Set 2H.

Please call me if you have any questions.

Sincerely,

CH2M HILL

John L. Carrier, J.D.
Program Manager

Enclosure
c: POS List
Project File

Ivanpah Solar Electric Generating System (ISEGS)

(07-AFC-5)

Data Response, Set 2H

(Response to Data Request: Soil & Water)

Submitted to the

California Energy Commission

Submitted by

Solar Partners I, LLC; Solar Partners II, LLC; Solar Partners IV, LLC; and Solar Partners VIII, LLC

May 13, 2009

With Assistance from

CH2MHILL
2485 Natomas Park Drive
Suite 600
Sacramento, CA 95833

Introduction

Attached are Solar Partners I, LLC, Solar Partners II, LLC, Solar Partners IV, LLC, and Solar Partners VIII, LLC (Applicant) responses to the California Energy Commission (CEC) Staff's data requests for the Ivanpah Solar Electric Generating System (Ivanpah SEGS) Project (07-AFC-5). The CEC Staff served these data requests on May 8, 2008, as part of the discovery process for Ivanpah SEGS. The responses are grouped by individual discipline or topic area. Within each discipline area, the responses are presented in the same order as CEC Staff presented them and are keyed to the Data Request numbers. New graphics or tables are numbered in reference to the Data Request number. For example, the first table used in response to Data Request 15 would be numbered Table DR15-1. The first figure used in response to Data Request 15 would be Figure DR15-1, and so on. AFC figures or tables that have been revised have "R1" following the original number, indicating revision 1.

Additional tables, figures, or documents submitted in response to a data request (supporting data, stand-alone documents such as plans, folding graphics, etc.) are found at the end of a discipline-specific section and may not be sequentially page-numbered consistently with the remainder of the document, though they may have their own internal page numbering system.

The Applicant looks forward to working cooperatively with the CEC and BLM staff as the Ivanpah SEGS Project proceeds through the siting process. We trust that these responses address the Staff's questions and remain available to have any additional dialogue the Staff may require.

Soil and Water Resources (140)

BACKGROUND

Some elements of Data Request 58, the Drainage Erosion and Sediment Control Plan (DESCP), were not answered.

DATA REQUEST

140. Please provide a final DESCP with all elements answered, including those itemized below.

a. Typical best management practices (BMPs) were provided in the draft DESCP. Due to the size of the project site, site-specific BMPs for both the construction and operation phases need to be identified on topographic maps for all areas except the power block area where BMPs have already been identified on topographic maps. Please provide these site-specific BMPs for the construction and operation phases.

b. In Section 4.0 of the draft DESCP, a timing and maintenance schedule was provided, but only a general level of detail. A detailed schedule of the timing of the BMPs to be employed and a maintenance schedule for all BMPs needs to be provided for each phase of the project construction and operation. Please provide this detailed schedule.

d Page 10 of the draft DESCP, Table 3.4-1, cut volumes of soil are greater than the fill volumes. The text states that there will be no soil exported offsite. This apparent difference needs to be reconciled and explained.

e. Page 17 of the draft DESCP states that there will be a concrete washout area used during construction. The location and size of this washout area need to be shown on a map of the project site and discussed in the text.

Response: The DESCP has been revised to incorporate the low impact design for stormwater management. Revision 2 of the document is provided as Attachment DR140-1B.

Attachment DR140-1B
Preliminary Draft Plan
Revision 2

Drainage, Erosion, and Sediment Control Plan

Ivanpah Solar Electric Generating System

San Bernardino County, California

(07-AFC-5)

Submitted to the

California Energy Commission

Submitted by

Solar Partners I, LLC
Solar Partners II, LLC
Solar Partners IV, LLC
Solar Partners VIII, LLC

With Technical Assistance by

CH2MHILL

Sacramento, California
May 2009

Contents

Appendixes

1.0 Introduction

This Preliminary Draft Drainage, Erosion, and Sediment Control Plan (DESCP) has been prepared in anticipation of the California Energy Commission's (CEC) approval of the proposed Ivanpah Solar Electric Generating System (Ivanpah SEGS or project) (07-AFC-5). Ivanpah SEGS is a solar energy complex composed of three separate facilities owned by Solar Partners I, LLC; Solar Partners II, LLC; and Solar Partners VIII, LLC; and related shared facilities owned by Solar Partners IV,LLC (hereafter "Applicant"), located in southern California's Mojave Desert, near the Nevada border, to the west of Ivanpah Dry Lake. The project will be located in San Bernardino County, California, on federal land managed by the Bureau of Land Management (BLM). This DESCP was prepared in response to CEC Staff Data Requests 139-140 in the CEC's data request letter dated May 8, 2008.

This DESCP is preliminary in nature because it has been prepared in advance of the final phase of construction planning and engineering design, during which the details of the construction schedule and certain aspects of erosion control design will be finalized. Per the request of the CEC and BLM, the final site layout, site drainage, and erosion control design will be prepared in advance of the final phase of construction planning and engineering design. This DESCP will be updated once the final site layout, site drainage, and erosion control design has been completed. Therefore, this document contains placeholders for information (i.e., detailed schedule, final BMP map) that will become available once the final site layout, site drainage, and erosion control design has been completed.

Once this DESCP is finalized, it will demonstrate that the project will not cause an increase in offsite flooding potential or sedimentation during the construction phase by using standard Best Management Practices (BMPs), and that the project will meet all local, state, and federal regulatory requirements associated with the protection of water quality and soil resources. In addition, the final DESCP will ensure compliance with the requirements of the Lahontan Regional Water Quality Control Board (RWQCB) as they relate to construction and post-construction BMPs.

1.1 Drainage, Erosion, and Sediment Control Plan Elements

This DESCP includes the following elements:

- **Vicinity Map –** This map indicates the locations of all project elements and depicts significant geographic features, including watercourses, swales, storm drains, and sensitive areas (Figure 1 – all figures are included in Appendix A).
- **Site Delineation –** The Ivanpah SEGS site and all project elements are delineated on a map showing all areas subject to soil disturbance and the location of all existing and proposed structures, pipelines, roads, and drainage facilities (Figure 2).
- **Watercourses and Critical Areas –** The DESCP shows the locations of watercourses and critical areas such as swales, creeks, rivers, wetlands and other environmentally sensitive areas (Figure 8).

- **Drainage –** The DESCP provides a topographic site map showing existing, interim and proposed drainage systems; drainage area boundaries; watershed size in acres; and the hydraulic analysis (preliminary stormwater calculations are located in Appendix B) to support the selection of BMPs to divert offsite drainage around and through the plant and laydown areas. Hydrology calculations will be performed using methods that, at a minimum, adhere to the TR-55 (SCS) method. Calculations will determine the amount of pre- and post-development stormwater run-on and run-off for each basin or sub-basin within each facility.
- **Clearing and Grading –** The DESCP provides clearing and grading plans to show elevations, slope, location, and extent of proposed grading. The locations of any disposal areas, fills, or other special features are also shown.
- **Best Management Practices –** The DESCP describes the location, timing, and maintenance schedule of BMPs to be used. Final design and placement of the BMPs will take place during the final phase of construction planning after licensing.

1.2 Federal Clean Water Act

The federal Clean Water Act (CWA) and subsequent amendments were established "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters," under the enforcement authority of the US Environmental Protection Agency (EPA). The CWA established the National Pollutant Discharge Elimination System (NPDES) program to protect water quality of receiving waters. Under the CWA, Section 402, discharge of pollutants to receiving waters is prohibited unless the discharge is in compliance with an NPDES permit. In California, the USEPA has determined that the State Water Resources Control Board (SWRCB) and its nine RWQCBs have sufficient authority under state law to administer and enforce the federal NPDES permitting program. The project site is located within the boundaries of the Lahontan RWQCB. Discharges from the project site during operations will be regulated under a new, individual NPDES permit for industrial activities (operations are addressed in the project's Industrial Stormwater Pollution Prevention Plan) and under a statewide NPDES permit during construction activities discussed in this document.

1.3 Project Overview

The Ivanpah SEGS will be located in southern California's Mojave Desert, near the Nevada border, to the west of Ivanpah Dry Lake, in San Bernardino County, California, on federal land managed by BLM (Figure 1). The three solar concentrating thermal power plants are based on solar power tower (SPT) and heliostat mirror technology, in which heliostat (mirror) fields focus solar energy on power tower receivers near the center of the heliostat array. The Ivanpah SEGS will be constructed in three phases: two 100-megawatt (MW) phases (known as Ivanpah 1 and 2) and a 200-MW phase (Ivanpah 3). The phasing is planned so that Ivanpah 1 (the southern-most site owned by Solar Partners II, LLC) will be constructed first, followed by Ivanpah 2 (the middle site, owned by Solar Partners I, LLC), then Ivanpah 3 (the 200 MW plant on the north owned by Solar Partners VIII, LLC), though the order of construction may change. Each 100-MW site requires about 917 acres (or 1.4 square miles); the 200-MW site is

about 1,836 acres (or about 2.9 square miles). The total area required for all three phases, including the Administration/Operations and Maintenance building, the gas tap and metering stations, the Southern California Edison (SCE) substation, groundwater production wells, access roads and re-routed trails and linear facilities is approximately 4,060 acres. The Applicant has applied for right-of-way grants for the land from BLM. Although this is a phased project, it is being analyzed as if all phases are operational.

Each of the three proposed plants will consist of heliostat fields surrounding a power block, which is supplied with the necessary utilities through a utility corridor. Each of the plants will be connected to SCE's planned step-up substation, which will in turn tie into SCE's electric-power transmission network (or grid) through an existing (115-kV) transmission line that runs across the project area between Ivanpah 1 and 2.

Ivanpah 1 and 2 will each have heliostat arrays consisting of 55,000 heliostats; Ivanpah 3 will have heliostat arrays consisting of up to 104,000 heliostats.[1] The heliostat arrays would be arranged around a SPT, and automatically track the sun throughout the day reflecting the solar energy to the boiler on top of the SPT.

Each heliostat is 7.2 feet high by 10.5 feet wide (2.20 meters by 3.20 meters). Each heliostat consists of two mirrors mounted on a single pylon, along with a computer-programmed aiming control system that directs the motion of the heliostat to track the movement of the sun.

Ivanpah 1, 2 and 3 will each have a power block located in the approximate center of the heliostat array. The power block will include a SPT, a receiver boiler, a steam turbine generator (STG) set, air-cooled condensers, and other auxiliary systems.

The SPT is a metal structure designed specifically to support the boiler and efficiently move high-quality steam through a STG at its base. The receiving boiler is a traditional high-efficiency boiler positioned on top of the SPT.

The power block consists of a conventional Rankin-cycle STG with a reheat cycle, and auxiliary functions of heat rejection, water treatment, water disposal, and grid interconnection capabilities. To minimize water use, air (rather than water) will be used to cool the steam.

Each plant will have a backup diesel generator to provide power to operate boiler recirculation pumps, firewater pumps, and other small power consumers in the event of an emergency when power might otherwise be unavailable.

Two new groundwater production wells will be drilled and developed near the northwest corner of Ivanpah 1 and south of Ivanpah 2 to provide raw water for the Ivanpah SEGS project. The wells, and their respective pumping systems, will be sized for 100-percent redundancy and be connected to the proposed plants via underground pipelines. These wells are anticipated to supply water to all three plants to be used as make-up water. Groundwater will be used to supply domestic and industrial water needs. Drinking water will either be brought onsite or a small filter/purification system would be used to and provide potable water for drinking and sanitary uses (sinks, showers, and toilets) within the

[1] However, the power purchase agreement states that both Ivanpah 1 and 2 would have no more than 70,000 heliostats and Ivanpah 3 would have no more than 140,000 heliostats.

plants. A raw water tank with a capacity of approximately 250,000 gallons will be located at each power block. A portion of the raw water stored in the tank (150,000 gallons) will be designated for plant use while the majority would be reserved for fire water.

There would be a dirt access road leading to the groundwater production wells. The water supply line would go from the wells to the paved road on the northwest corner of Ivanpah 1 and run north to the administration and maintenance complex, Ivanpah 2, and Ivanpah 3 along the same corridor as the gas line; and south to Ivanpah 1 along the paved access road leading to the power block.

In addition, a monitoring well would be installed southeast of the administration and maintenance complex near the northwest corner of Ivanpah 1.

A package treatment plant will be used at the administration and maintenance complex to treat sanitary wastewater. Portable toilets will be placed within the power block areas of each facility, and will be serviced by a waste management firm on a regular basis.

A number of utilities will be routed between the individual facilities (internal utility corridors) and the combined facilities (external utility corridors). Within each Ivanpah SEGS facility, there will be a utility corridor that connects to the common area and the SCE substation. Each utility corridor will contain overhead electrical lines and telecommunication (fiber-optic) cables, and underground water and natural gas lines. The underground utility corridors will run parallel to the local access roads between the facilities and the common area.

Ivanpah 1, 2, and 3 would be interconnected to an existing SCE grid through an upgraded SCE 115-kV line passing between Ivanpah 1 and 2 on a northeast-southwest utility corridor. A new 115/220-kV SCE substation (Ivanpah substation) will be constructed between Ivanpah 1 and 2 that will be used to connect Ivanpah SEGS to the electrical grid.

External to the Ivanpah SEGS project, utilities including natural gas pipelines, telecommunications, and transmission lines will require upgrades or new construction. Natural gas for the package boilers at each plant will be delivered to the project via new 4- to 6-inch pipeline that will connect to the existing Kern River Gas Transmission line located 0.5 mile north of Ivanpah 3.

The telecommunication path from the Ivanpah substation to local carrier facilities would interface at the Mountain Pass area, and would consist of fiber-optic cable to be installed overhead on existing poles and through new underground conduits to be constructed in the substation and telecom carrier interface point.

Natural gas would be used as a supplementary fuel during project operation and each plant contains a small-package, natural gas-fired start-up boiler.

The existing gravel Colosseum Road will be upgraded to an asphalt-paved road between the project site and the existing asphalt-paved road near the Primm Golf Club. Additionally, the existing Colosseum Road will be relocated to the south of Ivanpah 2 to avoid passing through the Ivanpah 2 heliostat fields .

Maintenance paths, located concentrically around power block, will provide access to the heliostat mirrors for maintenance and cleaning. The paths will be located between every

other row of heliostats and will not be graded. There will also be maintenance paths on the inside perimeter of the project boundary fence. In addition, dirt roads will be installed diagonally through the heliostat fields and used for access to the heliostat maintenance paths. These dirt roads will follow existing topography.

An administration and maintenance complex will be located north of the entrance to the Ivanpah 1 plant.

The following public trails will be rerouted to allow continued use and access to the Ivanpah Valley and environs:

- Trial 699226, which passes through the northern third of Ivanpah 3, would be rerouted along the northern border of Ivanpah 3;
- Trail 699198 which passes between Ivanpah 2 and 3, would be rerouted between those two proposed plants;
- Unnumbered trail on the east side of Ivanpah 3, (north of the limestone outcrop), would be relocated outside the project site to provide access to the limestone outcrop.

Figures 2 and 21 show the site layout and location of all existing and proposed pipelines and roads. Figure 20 shows the site boundary plan. Figures 3 and 4 show the layout and utility plans for the Construction Logistics Area located between Ivanpah 1 and 2; Figures 5 through 7 and Figure 17 are the roadway, utility, and power block plans for Ivanpah 1. Locations of watercourses and critical areas such ephemeral washes are shown in Figures 8 and 9. Figure 15 shows the access roadway plan. All figures are provided in Appendix A.

The project will comply with all local, state, and federal regulatory requirements associated with the protection of water quality and soil resources, as indicated in the Application for Certification for the Ivanpah SEGS project.

1.4 Watercourses and Critical Areas

1.4.1 Watercourses

The project area is located in the Ivanpah hydrologic unit of the South Lahontan Watershed, which includes approximately 278,486 acres in the Ivanpah and Pahrump Valleys of California and Nevada. In this area, all drainage is internal with the rapid runoff from mountains and alluvial fans collecting in closed basins in the Ivanpah Valley. Major surface water features within the Ivanpah Valley include Ivanpah Lake, Roach Lake, and numerous springs and ephemeral washes. The Ivanpah Valley is a topographically closed basin and surface water drainage evaporates on Ivanpah Lake or Roach Lake. The Ivanpah Valley is part of a larger hydrologic system that includes both Ivanpah Valley and Jean Lake Valley. The portion of the valley in California is generally referred to as Ivanpah South, while the portion of the basin in Nevada is generally referred to as Ivanpah North.

The project site is located within the Ivanpah South portion of the valley. Ivanpah South includes the 35-square-mile Ivanpah Lake, several ephemeral waterways, and scattered springs along the mountain front. Overall surface drainage in Ivanpah South is towards Ivanpah Lake (DWR, 2004). Ivanpah Lake is located approximately 2 miles east and down

slope of the project area. Waterways in or near the project site include unnamed ephemeral washes. These ephemeral washes typically flow only in response to storm events. There are two mapped springs, Whisky Spring and Ivanpah Spring, located approximately 1.6 miles west of the proposed project site in the foothills of the Clark Mountains. There are no springs located on the project site.

1.4.2 Other Critical Areas

The project area is dissected by numerous ephemeral washes ranging in size from small (1 to 4 feet wide), weakly expressed erosional features to broad (over 10 feet wide) drainages. The active flow channels are devoid of vegetation and typically have a sandy-gravel substrate, although some washes also contain cobble and scattered larger rocks. Throughout the project area the majority of the washes are associated with Mojave Creosote Bush Scrub habitat. Species such as cheesebush, are common in some medium- to large-sized washes; especially in braided channels that contain slightly elevated areas intermixed with the active flow channels. Mojave Wash Scrub is limited to the larger washes (typically over 15 feet) with sandy gravel substrate and well defined banks.

Approximately 198.72 acres of ephemeral washes were identified and mapped in the project study area. Small to medium sized washes are common and widespread throughout the entire project area, while the larger washes are most abundant in the northern section of Ivanpah 3 as well as the eastern side of Ivanpah 2. The larger washes tend to dissipate into smaller, more braided channels as they progress downslope. No other wetlands or waters were identified in the project area.

2.0 Drainage

2.1 Precipitation

The project site is located in southern California's Mojave Desert in the Ivanpah Valley. Ivanpah Valley is a semi-arid, topographically closed basin. Average annual precipitation at the project site from 1971 to 2000 was between 5.5 and 6.7 inches. Most of the precipitation in the project area falls during January through March and July through September. The estimated rainfall for a 100-year 24-hour event is 3.28 inches, and 2.83 inches for a 6-hour event. For a 10-year 24-hour event the estimated rainfall is 1.92 inches, and 1.60 inches for a 6-hour event [2] (site characterization Technical Memoranda associated with stormwater management are included in Appendix B).

2.2 Drainage

Stormwater runoff at the site is predominantly sheet flow from west to east, eventually discharging into Ivanpah Dry Lake. In support of a low-impact design (LID), with exception of the power block areas, solar field development will maintain sheet flow where possible, with water exiting the site in existing natural contours and flows. In addition, the majority of the project site will maintain the original grades and natural drainage features and, therefore, requires no added storm drainage control.

Existing small to moderate ephemeral washes will remain intact at locations capable of being traversed by installation equipment. Large ephemeral washes will be graded to the extent necessary to provide equipment access. In limited areas such as the power blocks and administrative areas, a storm drainage system will be designed using diversions channels, by-pass channels, or swales to direct run-on flow from up-slope areas, and run-off flow through and around each facility (Figure 9). The design will be developed for sheet flow for all storm events less than or equal to a 100-year, 24-hour storm event. Diversion channels will be designed so that a minimum ground surface slope of 0.5 percent shall be provided to provide positive, puddle-free drainage. Storm drainage channels will be sized to convey floods at relatively low velocities that will not result in significant scour or particle transport, and may be lined with a non-erodible material such as compacted rip-rap, geo-synthetic matting, or engineered vegetation. A sediment transport analysis will be completed prior to finalization of the DESCP.

Stormwater will be allowed to sheet flow across roads. An "Irish Bridge" style crossing will be constructed where permanent asphalt paved access roads cross major ephemeral washes on the site (see Figure 10 and Figure 22). The Irish Bridges will be constructed of reinforced concrete or gabion baskets and are being designed to prevent the scour and washout of major asphalt access roads during storm events (Figure 24).

[2] The general accepted design standard for a BMP is to a precipitation intensity of a 10-year, 6-hour event. The majority of the operational BMPs at the site, however, have been designed to a precipitation intensity of 100-year, 24-hour event.

When necessary, offsite stormwater drainage will be collected using a system of swales, berms, and existing ephemeral washes to control and direct stormwater through and around the Ivanpah SEGS site.

The stormwater drainage system will be designed by using the Soil Conservation Service (SCS) method (TR-55), and by determining the amount of rainfall during a specific rainfall storm event. This method is in accordance with requirements specified in the most current version of the San Bernardino County and Clark County requirements.

All surface runoff during and after construction will be controlled in accordance with the requirements of the NPDES General Permit for Construction Activities, the requirements of the San Bernardino Water Quality Management Plan manual, and all other applicable laws, ordinances, regulations and standards. Stormwater management practices will follow the California Storm Water Quality Association (CASQA) California Storm Water BMP Handbook for Construction.

As described previously, this DESCP will be updated once the final site layout, site drainage, and erosion control design has been completed. Design drawings would be incorporated into the DESCP once this information is available.

2.3 Hydraulic Analysis

Preliminary stormwater calculations are located in Appendix B. The watershed of the project area is 14,856 acres in size.

Hydrology calculations will be performed using methods that, at a minimum, adhere to the TR-55 (SCS) method. Calculations will determine the amount of pre- and post-development stormwater run-on and run-off for each basin or sub-basin within each facility.

San Bernardino County and Clark County requirements will be used (where applicable) to classify soil characteristics, expected soil types, and other design criteria necessary for use with the TR-55 calculations. Offsite flows will be determined using the western watershed boundaries from available state watershed information, contour intervals, and available soil mapping information. Watersheds will be further broken down into sub-basins as required to determine the western flow from the ephemeral washes upslope of the Ivanpah SEGS project areas. This process is necessary to determine the offsite flow required to design the bypass channels through the developed Ivanpah SEGS site.

3.0 Clearing and Grading

3.1 Areas to be Cleared and Graded

The existing site has about a 5 percent relatively uniform natural slope up from west to east, located on a relatively small alluvial runoff drainage basin, which can be accommodated by the heliostat fields. Using an LID approach, open spaces will be preserved and left undisturbed as much as possible with respect to site topography and access requirements.

Vegetation will be cleared in areas that do not need leveling or grading but where the existing terrain will not permit access of installation equipment and materials during construction. Vegetation will be cut at a height that allows clearance for heliostat function and leaves the root structures intact. The vegetation will be cut with a flail-type mower mounted on skids, which will be mounted on a low-ground pressure tractor (approximately 4.2 pound per square inch [psi]). Occasional cutting of the vegetation may be required to control plant regrowth that could affect heliostat mirror movement. Where existing site topography is favorable, the natural drainage features will be maintained

Clearing and grubbing (roots to be removed) of the site is to be performed as required for access roads for each facility, power blocks, construction parking and laydown areas, and in other common areas where the existing topography requires modification in order to provide access for installation equipment and materials during construction (reference Figures 11 through 14).

Crossing of existing washes will be achieved by the proper equipment selected and/or designed for project. Equipment selection will consider the following:

- Maximum slope capabilities
- Wheel base
- Width of footprint
- Weight of equipment and ground pressure exerted

At some washes, slopes may be too steep for equipment, and cuts into the side of the existing embankments may be necessary. At portions of the site, surface rocks and boulders may be relocated to allow proper installation of heliostats and facilities. Boulders will be harvested using a Caterpillar 950 (gross vehicle weight of 40,000 pounds [lbs] or similar), front-end wheel loaded with high floatation tires. The tires will generate much less impact than standard Caterpillar tires. The loader will be equipped with a skeleton bucket to harvest rocks larger than about 10 or 12 inches in diameter.

The rocks are concentrated in zones within the northeastern 170-acre area of Ivanpah 3. In this area, there may be up to 135,000 cubic yards (yd3) of material graded and rock harvested. These rocks and boulders will be used for rip-rap and other uses where possible. These areas of light grading will not be compacted to optimum moisture content; rather compaction efforts will attempt to attain natural compaction to ensure existing infiltration

rates. Site grading will be designed to maintain all local materials on site and minimize the import of off-site material.

Heavy to medium grading will be performed within the Ivanpah SEGS project's proposed receiver tower and power block areas, the substation, and within the administration building area. Within each of these individual areas, the Applicant will approximately balance earthwork cuts and fills. The total quantity of cut anticipated for these areas is approximately 110,000 cubic yards. The majority of earthwork in the power block and common areas will be excavated and compacted with Caterpillar D-9 size bulldozers and sheepsfoot compactors. These areas will be compacted to the recommendations of the geotechnical report.

The surface soil grade of each facility will be designed to provide the minimum requirements for access of installation equipment and materials during site construction and operations. Most of the natural drainage features will be maintained and any grading required will be designed to promote sheet flow where possible.

Areas disturbed by grading will be hydro-mulched, (or as specified in the revised Closure, Revegetation and Rehabilitation Plan), and/or protected by other erosion control BMPs.

Grade is to be designed to provide positive drainage of rainfall runoff away from each structure.

Embankments and excavated areas shall have the following slopes:

- Permanent embankments and excavations: 3 horizontal to 1 vertical (3:1) or flatter.
- Temporary embankments and excavations: In accordance with California's Occupational Safety and Health Administration (CalOSHA) requirements for excavation.

Slopes of excavated areas may be hydro-mulched (or as specified in the revised Closure, Revegetation and Rehabilitation Plan), to help eliminate and protect soils from rutting and scouring. Surface water will not to be permitted to flow uncontrolled down any embankment slope.

Where grade surface is flat or rises from the edge of an excavation, the top of the excavated slope will be protected by a low berm that will extend to a point at each end where the grade has a positive slope away from the excavation. The stormwater runoff discharge from this protective system will be directed to the edge of the excavation to prevent edge and slope scour.

Where job conditions require the temporary use of excavated slopes steeper than listed above, the cutting of such slopes and protective means employed will maintain the stability of the slopes in accordance with OSHA Part 1926, Subpart P.

Slopes of embankments will be protected against rutting and scouring during construction in a manner similar to that required for excavated slopes.

Reusable local materials will be hauled to lay-down areas for reuse or placed directly in the fill or backfill locations. A stone crusher facility may be utilized on site for the production of sub-grade materials (gravel) from local stone. Fill and backfill material will be compacted to

the requirements of the project geotechnical report. Material that do not meet the requirements for fill, backfill, or sub-grade shall be disposed of on site in locations designated by the Applicant.

Finish grade in the solar field areas will maintain natural drainage features where practical and grading is to be designed to promote sheet flow where possible.

Parking areas for construction workers and laydown areas for construction materials will be prepared. Detailed information regarding the location of the laydown and parking areas within the solar field will be developed and incorporated into the Final DESCP after a Contractor is hired.

The existing Colosseum Road will be upgraded to an asphalt-paved road between the project site and the existing asphalt-paved road near the Primm Golf Club. Additionally, a portion of the existing Colosseum Road will be relocated to the south of Ivanpah 2 to avoid passing through the heliostat fields.

Maintenance paths, located concentrically around power block and between every other row of heliostats, will not be graded. There will also be maintenance paths on the inside perimeter of the project boundary fence. These paths will be used to monitor and maintain the perimeter fence. In addition, dirt roads will be installed diagonally through the heliostat fields and used for access to the heliostat maintenance paths. These dirt roads will follow existing topography.

Vehicle wash stations will be provided to clean vehicle wheels prior to exiting the construction area.

After final site design and prior to any soil disturbance, the Applicant will prepare the Final DESCP. During construction, the Applicant will be required to follow the DESCP to prevent the offsite migration of sediment and other pollutants and to reduce the effects of runoff from the construction site. BMPs to be used at the site will be fully addressed in the Final DESCP; the DESCP will include the location of BMPs to be used, installation instructions, and maintenance schedules for each BMP for proposed BMP locations in this DESCP).

3.2 Location of Disposal Areas, Fills or Other Special Areas

All excavated soil will be used onsite for grading and leveling purposes and no soils will be disposed of offsite.

3.3 Existing and Proposed Topography

The site has about a 5 percent relatively uniform natural slope up from west to the east, which can be accommodated by the heliostat fields (Figure 16). The sites' topography varies across each heliostat field requiring different levels of disturbance to obtain the final topography suitable for the erection and operation of the heliostats. In areas where the existing terrain will permit access, grading will be restricted and only vegetation will be cleared. In areas where the existing topography requires modification, access will be improved by leveling (cut and filling) or conventional grading (where required).

At completion of the project, onsite drainage will be accomplished through gravity flow. Stormwater will flow through the heliostat fields and be diverted around structures such as the power blocks on their north and south sides in drainage channels, to channel storm runoff around each area before overflowing through native stone rip-rap to reinstate natural sheet flow conditions (Figures 9, 23, and 24).

3.4 Volumes of Cut and Fill

The grading of the site to design elevations will require cut and fill. Preliminary cut and fill volumes for each project element will be available as part of the 90 percent design package. Trenches excavated for the underground utilities will be entirely refilled. No surplus soil is expected. The updated information will be incorporated into the Final DESCP.

4.0 Project Schedule

Construction would take place over approximately 48 months, from the first quarter of 2010 to the fourth quarter 2013. Commercial operations are expected to commence in 2011 at Ivanpah 1, in 2012 at Ivanpah 2, and in 2013 at Ivanpah 3. Major milestones are listed in Table 4-1. A more detailed project schedule will be provided in a future draft of this DESCP once more detailed information on the project design and construction are known and a Contractor has been selected.

TABLE 4-1
Project Schedule Major Milestones

Activity	Date
Begin Construction	First Quarter 2010
Ivanpah 1 Commercial Operation	Fourth Quarter 2011
Ivanpah 2 Commercial Operation	Fourth Quarter 2012
Ivanpah 3 Commercial Operation	Fourth Quarter 2013

4.1 Mobilization

The selected Contractor will mobilize and develop temporary construction facilities and laydown areas within the construction logistics area (between Ivanpah 1 and 2) and adjacent to the power block of the unit being constructed. Clearing and grubbing will start in the power block area and last 4 months. Areas cleared and grubbed will be smoothed by 1 grader and compacted by 2 vibrating rollers over a period of 5 months.

4.2 Heliostat Erection

Solar field erection works will require at least two pre-assembly sheds for assembling heliostat structures. Approximately 55,000 heliostats will need to be erected in each Ivanpah 1 and 2, with Ivanpah 3 requiring about 104,000 heliostats. Fabrication buildings will be used to assemble heliostats and for other work during all three construction phases. These buildings will be located in the construction logistics area, which is situated between Ivanpah 1 and 2. Once construction of Ivanpah 3 is complete, the temporary buildings will be removed and the area restored.

The heliostats are installed in two steps using LID principles. Initially, the support pylons are installed using a sonic (vibratory) technology, and then the mirrors and aiming system are mounted to the pylon. Installation of the 6-inch galvanized heliostat pylons is presently planned to be installed with a rubber-tire hydraulic machine. The pylons will be vibrated into the ground and the machine will further be stabilized with outriggers. The siting of pylons will be guided by global positioning system technology. The vibratory installation allows the 6-inch diameter pylons to be embedded in the ground without the use of

conventional drilling techniques, or generation of drill cuttings. The installation of the heliostat mirrors will be accomplished with a rough terrain crane. The crane will be able to mount mirrors to four pylons before moving to next location. Mirrors will be delivered by a lightweight All Terrain Vehicle (ATV) and light weight trailers.

4.3 Power Block and Towers

Concrete, mechanical and electrical works will be performed over a period of 15 to 16 months. The construction logistics area, located between Ivanpah 1 and 2, will be used for the fabrication sheds and construction parking. Construction parking may also occur near the power blocks. However, temporary laydown of materials at each site will generally occur in the vicinity of active construction work.

5.0 Best Management Practices

The erosion and sedimentation control BMPs will be designed to meet the requirements of San Bernardino County (California) and Clark County (Nevada), unless other specific direction is provided by the BLM. In cases where a county grading permit is required, the general requirements for that permit are subject to the San Bernardino County General Plan and the San Bernardino County Development Code.

Using an LID approach, open spaces will be preserved and left undisturbed as much as possible with respect to site topography and access requirements. The project has been designed to impact as small an area as possible at any given time, and for construction to proceed as expediently and efficiently as possible; thereby, limiting the amount of exposed soil at any one given time.

The following sections present standard construction BMPs, most of which are described in the *California Storm Water Best Management Practice Handbook* (2003) and the *Caltrans Storm Water Quality Handbook* (2003). These resource handbooks provide comprehensive details on BMP implementation and will be obtained and reviewed by managers for all construction contractors that may have an impact on implementation of the DESCP. Appendix C contains the CASQA Handbook BMP factsheets with detailed descriptions of the BMPs discussed in the following sections. The fact sheets also include the maintenance practices for each BMP. Figures 18 and 19 are hypothetical construction BMP plans and will be further developed during the final project design phase. The Final DESCP will include locations and details of all BMPs to be used during the construction, including for linear features, such as roads and pipelines.

The following sections present the recommended construction BMPs for stormwater pollution prevention at the Ivanpah SEGS construction laydown areas, plant site, and linear facilities. Each section provides information on BMP implementation as it relates to the activity being performed. BMPs that may have an impact on implementation of the DESCP will be reviewed by managers and construction contractors. While performing the work, the contractors may implement additional control measures, if necessary.

5.1 General Erosion and Sediment Control Measures

BMPs will be used to help maintain water quality, protect property from erosion damage, and prevent accelerated soil erosion or dust generation. Temporary erosion control measures would be implemented before construction begins and they would be evaluated and maintained during construction. These measures typically include mulching, physical stabilization, dust suppression, berms, ditches, and sediment barriers. These measures would be removed from the site after the completion of construction.

To reduce erosion, project construction will minimize land disturbance by limiting construction activities only to areas that are essential to the installation and operation of the project.

Grading is not intended to level the site, but rather to prepare the site for installation and future maintenance of the heliostats. Vegetation will only be cleared in areas where the existing terrain will not permit access of installation equipment and materials during construction. Vegetation will be cut at a height that allows clearance for heliostat function and leaves the root structures intact to anchor the soil, reducing the potential for erosion. At this time it is unknown whether the cleared vegetation will be burned, or mulched into the soil, and/or stockpiled for transport offsite. The matter is being discussed with the regulatory agencies and the information will be incorporated into the Final DESCP. BLM may also open the site prior to grading to allow the public to salvage succulents. If salvage is allowed, it will be done in accordance with the Closure, Revegetation and Rehabilitation Plan.

Clearing and grubbing (roots to be removed) and extensive site grading will be limited to the power block areas, receiving towers, major access roads, possibly the rerouted trails, the substation, and in common areas where the existing topography requires modification in order to provide access for installation equipment and materials during construction. Disking and light grading may be used prior to compaction by rolling. Disturbed soils that are permanently covered by project facilities will be compacted to reduce the rainfall absorptive capacity and vegetative productivity of the soils.

It will be necessary to segregate and stockpile surface soils and organic matter during construction and excavation. In areas of substantial grading, native vegetation may be harvested for possible reuse to obtain-long term soil stabilization. All excavated soils are to be reused during construction at the site to prevent subsequent erosion and sedimentation issues. Materials suitable for backfill will be stored in stockpiles at designated locations using proper erosion and sediment control methods.

Stone filters and check dams will be strategically placed throughout the project site to provide areas for sediment deposition and to promote the sheet flow of stormwater. Where available, native materials (rock and gravel) will be used for the construction of the stone filter and check dams. In addition, diversion berms are to be used to redirect stormwater, as required.

Groundwater will be applied to disturbed soil areas of the project site to control dust and maintain optimum moisture levels for compaction as needed.

The existing Colosseum Road will be upgraded to an asphalt-paved road between the project site and the existing asphalt-paved road near the Primm Golf Club. All public roadways (Yeats Well Road and Colosseum Road) will be maintained free from dust, dirt and debris caused by construction activities. These streets will be swept at the end of the day if visible soil materials are carried onto them.

Non-active areas will be stabilized as soon as feasible after construction is complete and no later than 14 days after construction in that portion of the site has temporarily or permanently ceased.

A mitigation monitoring plan also will be developed in conjunction with BLM and CEC Staff to set performance standards and monitor the effectiveness of BMPs. This plan will address the timing and methods of such measures, as well as reporting and response

requirements. Personnel will receive training to conduct their jobs properly and recognize and report abnormal/adverse situations so that they can be quickly corrected.

Maintenance of BMPs will be according to measures outlined in the applicable CASQA Handbook BMP factsheets. Table 5-1 provides an implementation, inspection, and maintenance schedule for each BMP that would be implemented during the construction of each phase of the Ivanpah SEGS project.

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
TEMPORARY EROSION CONTROL BMPs			
EC-1, Scheduling	During preparation of Final SWPPP	Review periodically to make sure it is being followed.	– Update as necessary – If progress deviates, take corrective actions
EC-2, Preservation of Existing Vegetation	Prior to clearing and grading activities	Daily, make sure that construction fencing is maintained.	– Retain protective measures until construction activity is complete – Repair any fencing that has been disturbed or has fallen – Fill trenches as soon as possible
EC-3, Hydraulic Mulch	In succession with construction activities	Before and after rain events, daily during extended rain events, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair areas where erosion is evident and re-apply BMP as soon as possible
EC-5, Soil Binders	In succession with construction activities	Before and after rain events, daily during extended rain events, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair areas where erosion is evident and re-apply BMP as soon as possible – Re-apply as needed to maintain effective soil stabilization
EC-6, Straw Mulch	In succession with construction activities	Before and after rain events, daily during extended rain events, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair areas where erosion is evident and re-apply BMP as soon as possible – Re-apply as needed to maintain effective soil stabilization over disturbed areas and slopes

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
EC-7, Geotextile and Mats	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Replace/ repair as necessary – Repair areas where erosion is evident and re-apply BMP as soon as possible – If washout or breakage occurs, re-install material after repairing damage to the slope or channel
EC-9, Earth Dikes & Drainage Swales	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season; inspect for washouts.	– Replace lost riprap, damaged linings or soil stabilizers as needed – Remove debris and sediment – Repair linings and embankments as needed
EC-10, Velocity Dissipation Devices	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season; inspect for scour.	– Repair fabric and replace riprap that has washed away – Repair damage to slopes
EC-11, Slope Drains	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season; inspect for scour; inspect pipes for leakage; inspect slope drainage for accumulations of debris and sediment; inspect pipe anchors.	– If outlet eroded, repair damage and install additional energy dissipation measures – If scouring downstream, potential need to reduce flows being discharged into the channel or implement other preventive measures – Remove debris and sediment from inlets and outlets; flush drains if necessary – capture and settle out sediment from discharge – Repair undercutting at inlet and if needed, install flared section or rip rap around the inlet – Repair leaking pipes and restore damaged slopes – Install additional anchors if pipe movement is detected

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
EC-12, Streambank Stabilization	In succession with construction activities	Weekly during the rainy season or discharge of non-stormwater, bi-weekly during the non-rainy season.	– Repair damage
TEMPORARY SEDIMENT CONTROL BMPs			
SE-1, Silt Fence	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair undercut silt fences – Repair or replace split, torn, slumping, or weathered fabric – Repair up-rooted sections – Clean out collected soils when greater than 1/3 of the barrier height
SE-2, Sediment Basin	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season; inspect basin banks for seepage and structural soundless; inspect inlet and outlet structures and spillway for damage or obstructions; inspect fencing.	– Repair damage to inlet and outlet structures and spillway and remove obstructions as needed – Stabilize eroded areas at inlet and outlet area – Repair fencing as needed – Clean out collected soils when sediment accumulation reaches ½ of the designated storage volume – Remove standing water from basin within 72 hours after accumulation – Attend dewatering operations – Remove accumulation of live and dead floating vegetation in basins during every inspection – Remove excessive emergent and perimeter vegetation as needed

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
SE-3, Sediment Trap	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season; inspect trap banks for seepage and structural soundness; inspect outlet area for erosion; inspect fencing; inspect outlet structure and spillway for damage or obstructions.	– Stabilize eroded areas at outlet area – Repair trap banks as needed – Repair outlet structure and spillway and remove obstructions as needed – Repair fencing as needed – Take corrective measures if does not dewater completely in 72 hours or less – Remove accumulated sediment when reaches 1/3 of trap capacity – Attend dewatering operations – Remove vegetation from trap
SE-4, Check Dams	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Replace missing rock and bags – Replace degraded bags – Remove accumulated sediment when reaches 1/3 of the barrier height (not required if system in place to control the grade) – Remove accumulated sediment prior to soil stabilization
SE-5, Fiber Rolls	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Replace split, torn, unraveling, slumping, rotted or crushed sections – Clean out collected soil when reaches 1/2 the designated sediment storage depth (not required if system in place to control the grade)
SE-6, Gravel Bag Berm	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Replace bags exposed to sunlight every 2 to 3 months – Repair/Reshape/Replace as needed – Repair washouts or other damage as needed – Clean out collected soil when greater than 1/3 of the barrier height

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
SE-7, Street Sweeping and Vacuuming	At the start of ground disturbance activities	Daily.	– When tracked or spilled sediment is observed outside the construction limits on Yeats Well Road or Colosseum Road, sweep daily – Increase sweeping frequency if necessary – Adjust brooms frequently to maximize efficiency
SE-8, Sandbag Barrier	In succession with construction activities	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Replace bags exposed to sunlight every 2 to 3 months – Repair/Reshape/Replace as needed – Repair washouts or other damage as needed – Clean out collected soil when greater than 1/3 of the barrier height
WIND EROSION CONTROL BMPs			
WE-1, Wind Erosion Control	At the start of ground disturbance activities	Check areas daily that have been protected to ensure coverage; inspect water truck for leaks.	– Fix leaks immediately – Improve coverage for areas missed
TRACKING CONTROL BMPs			
TR1, Stabilized Construction Entrance/Exit	Prior to other clearing and grading activities	Weekly during the rainy season or discharge of non-stormwater, bi-weekly during the non-rainy season; adjacent roads daily.	– Repair damaged sections – Remove sediment if clogged – Replace gravel when surface voids are visible – Keep roadway ditches clear
TR-2, Stabilized Construction Roadway	Prior to other clearing and grading activities	Weekly during the rainy season or discharge of non-stormwater, bi-weekly during the non-rainy season.	– Keep roadway ditches clear – Periodically apply additional aggregate on gravel roads – Active dirt construction roads are commonly watered three or more times per day during the dry season
TR-3, Entrance/Outlet Tire Wash	Prior to ground disturbance activities	Weekly during the rainy season; bi-weekly during the non-rainy season.	– Remove accumulated sediment to maintain system performance – Repair damage and wear as needed
NON-STORM WATER MANAGEMENT BMPs			

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
NS-1, Water Conservation Practices	In succession with construction activities	Weekly.	– Repair water equipment as needed
NS-2, Dewatering Operations	Prior to commencement of associated activity	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Unit specific maintenance – If sediment is commingled with other pollutants, dispose of in accordance with all applicable laws and regulations
NS-3, Paving and Grinding Operations	Prior to commencement of associated activity	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Keep ample supplies of drip pans or absorbent materials onsite – Maintain machinery regularly to minimize leaks and drips
NS-6, Illicit Connection/ Discharge	Prior to commencement of associated activity	Continuously.	– Report discharge immediately to owner and onsite project manager – Prohibit employees and subcontractors from disposing of non-job related debris or materials onsite
NS-8, Vehicle and Equipment Cleaning	Prior to the use of construction vehicles and equipment onsite	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair berms as needed – Remove liquids and sediment as needed – Monitor employees and subcontractors that appropriate practices are being implemented – Prohibit washing personal vehicles and equipment onsite
NS-9, Vehicle and Equipment Fueling	Prior to the use of construction vehicles and equipment onsite	Daily.	– Keep an ample supply of spill cleanup material on the site – Immediately clean up spills and properly dispose of contaminated soil and cleanup materials – Repair leaks or remove equipment offsite
NS-10, Vehicle & Equipment Maintenance	Prior to the use of construction vehicles and equipment onsite	Daily.	– Prohibit the maintenance of vehicle and equipment on-site – Keep an ample supply of spill cleanup material on the site – Maintain waste fluid containers in leak proof condition – Repair leaks or remove equipment offsite

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
NS-12, Concrete Curing	Prior to commencement of associated activity	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Inspect cure containers and spraying equipment for leaks prior to use – Monitor employees and subcontractors that appropriate measures for storage, handling, and use of curing compounds are being implemented
NS-13, Concrete Finishing	Prior to commencement of associated activity	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Sweep or vacuum up debris from sandblasting at the end of each shift – Remove and contain liquid and solid waste from containment structures and general work area at the end of each shift
WASTE MANAGEMENT AND MATERIALS POLLUTION CONTROL BMPs			
WM-1, Material Delivery and Storage	Prior to the storage or use of materials onsite	Weekly during the rainy season, bi-weekly during the non-rainy season.	– Keep an ample supply of spill cleanup material near the storage area appropriate for the materials being stored – Keep storage areas clean and well organized – Repair any damaged perimeter controls – Repair damaged containment structures – Repair damaged or failing covers – Repair damaged liners
WM-2, Material Use	Prior to the storage or use of materials onsite	Weekly during the rainy season, bi-weekly during the non-rainy season.	– Spot check employees monthly to ensure appropriate practices are being employed – Provide additional training to those found to be storing, handling, or using materials inappropriately
WM-3, Stockpile Management	Prior to the storage or use of materials onsite	Before and after rain events, daily during extended rain events or discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Repair or replace perimeter controls and covers as needed
WM-4, Spill Prevention and Control	Prior to the storage or use of materials onsite	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Update spill control plans and stock cleanup materials as changes occur in the types of chemicals onsite – Stock appropriate spill control and cleanup materials onsite near storage, unloading, and maintenance areas

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
WM-5, Solid Waste Management	Prior to the storage or use of materials onsite	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Arrange for regular waste collection – Provide more waste storage if not adequate – Remove full dumpsters from the project site – Have stray litter placed in waste containers
WM-6 Hazardous Waste Management	Prior to the storage or use of materials onsite	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Arrange for regular hazardous waste collection – Keep waste storage areas clean and organized – Maintain ample spill control and cleanup materials in waste storage areas as appropriate for materials being stored – Repair damaged perimeter controls, containment structures, covers, and liners as needed – Clean up spills immediately and report in conformance with the applicable Material Safety Data Sheet – Maintain hazardous waste manifests onsite
WM-7, Contaminated Soil Management	Prior to commencement of associated activity	Weekly during the rainy season, bi-weekly during the non-rainy season; construction supervisor to monitor storage and disposal procedures.	– Coordinate with appropriate local, state and federal agencies – Implement WM-4 to prevent leaks and spills as much as possible
WM-8, Concrete Waste Management	Prior to commencement of associated activity	Weekly during the rainy season, bi-weekly during the non-rainy season.	– Maintain to provide adequate holding capacity with a minimum freeboard of 4 inches for above grade facilities and 12 inches for below grade facilities – Remove and dispose of hardened concrete – Cleanout washout facility, or provide new washout facility, once the washout is 75% full
WM-9, Sanitary/Septic Waste Management	Upon initiation of project activities	Weekly.	– Weekly cleaning and waste collection – Secure during windy conditions

TABLE 5-1
Implementation, Inspection, and Maintenance Schedule for BMPs During Construction of the Ivanpah SEGS Project

BMP	Implementation Timeframe	Inspection Frequency	Maintenance/Repair Program
WM-10, Liquid Waste Management	Prior to commencement of associated activity	Daily during the discharge of non-stormwater, weekly during the rainy season, bi-weekly during the non-rainy season.	– Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task – Dispose of any solids as described in WM-5 – Repair containment areas and captures devices as needed

The following general erosion and sediment control measures may be used during various phases of the project:

- Proper scheduling and sequencing of activities (EC-1)
- Preservation of existing vegetation (EC-2)
- Hydraulic mulch (EC-3)
- Soil Binders (EC-5)
- Straw mulch (EC-6)
- Placement of geotextiles, plastic covers, and erosion control blankets/mats (EC-7)
- Earth dikes and drainage swales (EC-9)
- Velocity dissipation devices (EC-10)
- Slope Drains (EC-11)
- Streambank stabilization (EC-12)
- Silt fences (SE-1)
- Sediment basin (SE-2)
- Sediment trap (SE-3)
- Check dams (SE-4)
- Fiber Rolls (SE-5)
- Gravel bag berm (SE-6)
- Street Sweeping and Vacuuming (SE-7)
- Sandbag Barrier (SE-8)
- Wind Erosion Control (WM-1)
- Stockpile management (WM-3)

5.1.1 Access Road, Entrance and Parking, and Laydown Areas/ Offsite Vehicle Tracking

A stabilized entrance/exit and tire washing stations will be in place to minimize or eliminate soils from being tracked off the project site from vehicles (see Figure 27). Primary access to the site is via the Yates Well Road interchange on I-15, and Colosseum Road to the west of the Primm Valley Golf Club. A part of Colosseum Road will be re-routed between Ivanpah 1 and Ivanpah 2 and paved from the Primm Valley Golf Club to the project site.[3] In

[3] A portion of this road may have been recently been paved from the golf club to their wells.

addition, the access roads to individual plants will be paved from their point of connection with Colosseum Road to the power block. Figure 25 depicts typical roadway details. The construction parking and laydown areas will be stabilized with coarse gravel. The gravel for these areas will have been harvested onsite. If insufficient material is available, gravel from outside sources would be utilized. All offsite gravel utilized onsite will be removed and transported offsite at completion of construction activities. All surfaces will be regularly watered to reduce generation of dust, but will not be excessively watered so as to generate runoff. Silt fencing or fiber rolls may be used at edges of these areas, as necessary to minimize sediment discharging into swales or ditches.

All public roadways (Yeats Well Road and Colosseum Road) will be maintained free from dust, dirt and debris caused by construction activities. These streets will be swept at the end of the day if visible soil materials are carried onto them.

The following control methods will be considered for offsite vehicle tracking, as necessary:

- Stabilized construction entrance/exit (TC-1)
- Stabilized construction roadway (TC-2)
- Tire wash (TC-3)
- Entrance/exit Street sweeping (SE-7)
- Paving and grinding operations (NS-3)

5.1.2 Dust Suppression and Control

During construction of the project and the related linear facilities, dust erosion control measures would be implemented to minimize the wind-blown loss of soil from the site. Groundwater will be applied to disturbed soil areas of the project site to control dust and maintain optimum moisture levels for compaction as needed, but will not be excessively watered so as to generate runoff.

The following control method will be considered for dust suppression, as necessary:

- Wind erosion control (WE-1)
- Water conservation practices (NS-1)

5.1.3 Ivanpah SEGS Site and Linear Facilities

Overall the project is being designed to maintain, to the extent possible, the existing sheet flow patterns on the site.

Stormwater will flow through the heliostat fields and be diverted around structures such as the power blocks on their north and south sides in drainage channels, to channel storm runoff around each area before overflowing through native stone rip-rap to reinstate natural sheet flow conditions. Relatively small rock filters and local diversion berms through the solar fields will discourage water from concentrating to maintain sheet flow.

Sediment control barriers would be placed in locations where offsite drainage could occur to prevent sediment from leaving the site. If used, sediment barriers would be properly installed, then removed or used as mulch after construction. Any soil stockpiles, including sediment barriers around the base of the stockpiles, would be stabilized and covered.

The excavated soil from trenching activities associated with construction of the natural gas pipeline and water line will be piled on one side of the trench and used for backfilling after the pipe is installed. The backfill will be compacted to protect the stability of the pipe and to minimize subsequent subsidence.

Primary access to the site is via the Yates Well Road interchange on I-15, and Colosseum Road to the west of the Primm Valley Golf Club. A portion of Colosseum Road will be re-routed between Ivanpah 1 and Ivanpah 2 and paved from its intersection with Yates Well Road to the project site. In addition, the access roads to individual plant sites will be paved from their point of connection with Colosseum Road to the power block. A stabilized entrance/exit will be provided to clean vehicle wheels prior to exiting the construction area (see Figure 27).

5.1.4 Site Stabilization and Demobilization

Overall the project is being designed to maintain, to the extent possible, the existing sheet flow patterns on the site.

As construction nears completion, areas used for parking, storage and laydown will be cleared and stabilized. Site areas disturbed during construction may be permanently stabilized by aggregate paving, bituminous paving, hydromulch, or approved soil binders.

At completion of the project, onsite drainage will be accomplished through gravity flow. Stormwater will flow through the heliostat fields and be diverted around structures such as the power blocks on their north and south sides in drainage channels, to channel storm runoff around each area before overflowing through native stone rip-rap to reinstate natural sheet flow conditions. Stormwater within the power block areas will pass through an oil/water/sand separator prior to discharge.

Within the heliostat array fields, the cut vegetation will have the root structures intact to anchor the soil, reducing the potential for erosion.

Heliostats are relatively small (about 13 feet high), contain no hazardous materials, and are not essential structures (Figure 26). Their potential structural failure in flood conditions also does not pose a risk to personnel, and the heliostat fields, therefore, they require no special flood protection measures. Onsite water consumption will be minimal—mainly to replace boiler feedwater blowdown and provide deionized water for washing heliostat mirrors. The latter is required in a washing cycle of 2 weeks, during which all heliostats are washed, to maintain them at full performance.

Stormwater will be allowed to sheet flow across paved access roads, and across Irish Bridges where the road crosses an ephemeral stream. Routine vehicle traffic during project operation would be limited to existing roads, most of which will be paved or covered with gravel. Mirror washing will be performed once every 2 weeks by the machine modified to have a reach to clean approximately eight mirrors before needing to move; thereby, allowing the machine to drive on every other maintenance path instead of every path every 2 weeks. Standard operating activities would not involve the disruption of soil. When linear facilities need to be inspected or maintained, vehicle traffic near these areas would be minimal.

Once the project grading plan has been finalized, a figure will be added to that shows the post-construction runoff and drainage patterns. In addition, the Final DESCP will include a schedule for maintenance of post-construction BMPs.

5.2 Other Controls

Ivanpah SEGS will use hazardous materials during construction, such as vehicle fluids, including oil, grease, petroleum, and coolants, paints, solvents and curing compounds. The project will comply with good engineering practices, applicable laws and regulations for the storage of these materials to minimize the potential for a release of hazardous materials, and will conduct emergency response planning to address public health concerns regarding hazardous materials use and storage.

5.2.1 Material Handling and Storage

All construction equipment will be maintained to control leaks and spills, and fueling will only be conducted within contained areas. Any contaminated soils resulting from spills will be dug up as quickly as possible, and then removed from the site for proper disposal. Reference the other sub-sections in Section 5.2 for additional control measures.

There will be a variety of chemicals stored and used during the construction of Ivanpah SEGS. All hazardous materials will be handled and stored in accordance with applicable codes and regulations. A Hazardous Materials Business Plan will be prepared if it is required by Title 19 California Code of Regulations and the Health and Safety Code (Section 25504). In accordance with these regulations, the Hazardous Materials Business Plan would include an inventory and location map of hazardous materials onsite and an emergency response pan for hazardous materials incidents. Specific topics to be covered in the plan include:

- Facility identification
- Emergency contacts
- Chemical inventory information (for every hazardous material above threshold limits)
- Site map
- Emergency notification data
- Procedures to control actual or threatened releases
- Emergency response procedures
- Training procedures
- Certification

If required, the Hazardous Materials Business Plan would be filed with the San Bernardino County Division of Environmental Health (DEH) and updated annually in accordance with applicable regulations. The San Bernardino County DEH will ensure review by and distribution to other potentially affected agencies including the local fire district.

The quantities of hazardous materials that will be onsite during construction will generally be limited to gasoline, diesel fuel, motor oil, hydraulic fluid, solvents, cleaners, sealants, welding flux, various lubricants, paint, and paint thinner. There are no feasible alternatives to vehicle fuels and oils for operating construction equipment. The types of paint required

are dictated by the types of equipment and structures that must be coated and by the manufacturers' requirements for coating.

The following BMPs will be considered for material handling and storage:

- Water Conservation Practices (NS-1)
- Paving and Grinding Operations (NS-3)
- Vehicle and equipment cleaning (NS-8)
- Vehicle and equipment refueling (NS-9)
- Vehicle and equipment maintenance (NS-10)
- Material delivery and storage (WM-1)
- Material use (WM-2)
- Stockpile Management (WM-3)
- Spill prevention and control (WM-4)
- Solid Waste Management (WM-5)
- Hazardous Waste Management (WM-6)
- Sanitary/Septic Waste Management (WM-9)

5.2.2 Foundations

During construction of the foundations, a concrete washout area will be required. The concrete washout area's location in the construction laydown area and size is shown in Figures 15 and 27. Dumping of excess concrete and washing out of delivery vehicles will be prohibited at other locations onsite. Notices will be posted to inform all drivers.

The following BMPs will be considered during the construction of foundations:

- Concrete waste management (WM-8)
- Concrete curing (NS-12)
- Concrete finishing (NS-13)

5.2.3 Solid and Hazardous Waste Management

During construction, the primary waste generated will be solid nonhazardous waste. However, some nonhazardous liquid waste and hazardous waste (solid and liquid) will also be generated. Most of the hazardous wastes will be generated at the plant site. The types of waste are described below.

5.2.3.1 Nonhazardous Solid Waste

Listed below are nonhazardous waste streams that could potentially be generated from construction activities.

Paper, Wood, Glass, and Plastics. Paper, wood, glass, and plastics will be generated from packing materials, waste lumber, insulation, and empty nonhazardous chemical containers during project construction. These wastes will be recycled where practical. Waste that cannot be recycled will be disposed of weekly in a Class III landfill. Onsite, the waste will be placed in dumpsters.

Concrete. Waste concrete will be disposed of in a Class III landfill or at clean fill sites, if available or will be recycled and disposed of at a construction and demolition site.

Metal. Waste metal, including steel from welding/cutting operations, packing materials, and empty nonhazardous chemical containers, and aluminum waste from packing materials and electrical wiring will be recycled where practical and nonrecyclable waste will be deposited in a Class III landfill.

5.2.3.2 Wastewater

Wastewater generated during construction will include stormwater runoff, pressure testing water, and equipment washdown water. Depending on the chemical quality of these wastewaters, they could be classified as hazardous or nonhazardous. The waste waters would be sampled and if they are hazardous would be disposed of in accordance with applicable regulations.

Stainless steel piping will be tested with demineralized water, while carbon steel piping will be pressure tested using either demineralized water or potable water. Demineralized water would be trucked in. After hydrostatic testing, the test water will be chemically analyzed for contaminants and discharged to the concrete holding basins located at the power block, unless the analysis shows that the water is contaminated, in which case the water would be trucked to an appropriate disposal facility. Temporary approvals for test water use and permits for discharge will be obtained by the construction Contractor, as required.

5.2.3.3 Hazardous Waste

Most of the hazardous waste generated during construction will consist of liquid waste, such as water from flushing and cleaning fluids, passivating fluid (to prepare pipes for use), and solvents. Some hazardous solid waste, such as welding materials, batteries, and dried paint, may also be generated.

Flushing and cleaning waste liquid will be generated as pipes are cleaned and flushed. The volume of flushing and cleaning liquid waste generated is estimated to be one to two times the internal volume of the pipes cleaned. The quantity of welding, solvent, batteries, and paint waste is expected to be minimal. Wastewaters generated during construction could also be considered hazardous, if demonstrated so by sampling.

The construction contractor will be considered the generator of hazardous construction waste and will be responsible for proper handling of hazardous waste in compliance with all applicable federal, state, and local laws and regulations. This responsibility will include licensing, personnel training, accumulation limits and times, and reporting and recordkeeping. The hazardous waste will be collected in satellite accumulation containers near the points of generation. It will be moved daily to the contractor's 90-day hazardous waste storage area located at the site construction laydown area. The waste will be removed from the site by a certified hazardous waste collection company and delivered to an authorized hazardous waste management facility, before expiration of the 90-day storage limit.

The following BMPs will be considered at the designated storage locations:

- Cover or store hazardous materials indoors, if possible (WM-1)
- Material delivery and storage (WM-1)
- Material use (WM-2)

- Spill prevention and control (WM-4)
- Solid waste management (WM-5)
- Hazardous waste management (WM-6)
- Concrete Waste Management (WM-8)
- Sanitary/Septic Waste Management (WM-9)

5.2.4 Potential Contaminated Soil

The project area is characterized by a desert scrub community dominated by creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*). The ground surface is primarily comprised of coalesced and dissected alluvial fans and desert washes.

It is unlikely that, with exception of light cattle grazing, there has been any other historical use of the site. Soils in the area are not expected to be contaminated. No existing site features have, as a result of past usage, contributed pollutants to stormwater (e.g., toxic materials that have been treated, stored, disposed of, spilled, or leaked onto the construction site).

As such, it is unlikely that contaminated soil will be encountered during construction. However, operators and construction personnel will be asked to report unusual conditions to the appropriate personnel and the area and/or material will be properly contained during investigative actions. If soils require temporary stockpiling, piles will be placed on and covered with plastic sheeting or tarps that are secured safely with sand bags and bermed with fiber rolls or silt fencing to prevent runoff from leaving the area. If required, samples will be collected and sent to a certified analytical laboratory for characterization. If contamination is detected, the waste will be handled and properly disposed of in an authorized waste management facility.

The following BMP will be considered:

- Contaminated Soil Management, WM-7

5.2.5 Groundwater/Dewatering Controls

It is unlikely that groundwater will require removal during the construction phase of Ivanpah SEGS because the groundwater table is believed to be located substantially below the maximum excavation depth.

If any contamination is detected via odors or visible sheens, the collected stormwater will be handled and properly disposed of in a manner consistent with federal, state, and local regulations. The following control methods will be considered for groundwater/dewatering controls, as necessary:

- Dewatering operations (NS-2)
- Liquid waste management (WM-10)

6.0 References

California Department of Water Resources (DWR). 2004. California's Groundwater – Bulletin 118. Basin Descriptions: Ivanpah Valley Groundwater Basin. http://www.groundwater.water.ca.gov/bulletin118/basin_desc/basins_s.cfm.

APPENDIX A

Figures

APPENDIX B

Stormwater Calculations

APPENDIX C

Best Management Practices

WEST YOST ASSOCIATES
Consulting Engineers

TECHNICAL MEMORANDUM NO. 2

DATE: March 6, 2009 Project No.: 351-00-08-01.004

TO: BrightSource Energy, Inc.

FROM: Mark Kubik, R.C.E. #50963

SUBJECT: ISEGS Stormwater – Preliminary Flo-2D Modeling for Pre-Project Conditions

INTRODUCTION

West Yost Associates is performing a study to define the potential flooding conditions at the proposed Ivanpah Solar Electric Generating System (ISEGS). The study is intended to establish the pre-project flooding conditions at the site; determine the potential impacts of the proposed project; and evaluate mitigation measures for the identified impacts. To-date, the evaluation has focused on defining the pre-project flooding conditions at the site using a combination of hydrologic and hydraulic models. This memorandum presents the preliminary analysis of pre-project flooding conditions at the project site. The principal purpose of this memorandum is to describe the approach to the analysis, to describe the preliminary results, and to solicit comments on the approach and results.

GENERAL APPROACH

The ISEGS is proposed to be located on alluvial fans bordering the western side of Ivanpah Valley, California. The project site occupies about 4,000 acres on the fans. The fans are bordered on the west by a mountain range. Precipitation on the mountain range and alluvial fans produces ephemeral stormwater flows within the ISEGS site.

Two hydrologic processes determine the stormwater flows: runoff generated within the mountain watersheds above the alluvial fans; and runoff generated on the alluvial fans. The two runoff processes combine to produce flood flows within the project site. Flood flows from the mountain watersheds are initially contained in incised channels near the apex of the alluvial fans. Once on the alluvial fans, the flood flows tend to follow somewhat random paths down the fans. As a result, the probability that a particular flood flow will be equaled or exceeded in a particular year at a particular location depends on both probability of the flood flow magnitude and the probability of the flood flow path passing through a particular location. With respect to alluvial-fan precipitation, the resulting flood flows tend to be distributed over the alluvial fan. Those flood flows at a particular location combine with the mountain flood flows to produce the overall flood flows at the location.

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The modeling approach for the ISEGS stormwater analysis is to use the HEC-1 computer program to calculate runoff hydrographs from the mountain watersheds and to use the Flo-2D model to calculate runoff from the alluvial fan area. The Flo-2D model is also used to route the combined mountain and alluvial fan runoff across the floodplain and within the channels.

HEC-1 is a commonly used model that simulates the rainfall-runoff process and will be used to produce the runoff hydrographs from the mountain watersheds. The model does not perform hydraulic calculations that are needed to define water surface elevations and velocities. Because the mountain areas are well outside of the project limits and the discharge locations from the mountains are stable and well defined, there is no need to calculate the flow depths and velocities in that area. Because of this, mountains were modeled with HEC-1 rather than Flo-2D. This helped to keep the Flo-2D model to a more manageable size.

Flo-2D is a two-dimensional surface-water-flow and sediment-transport model. The two-dimensional model will allow us to: (1) simulate the rainfall-runoff process on the alluvial fan areas; (2) evaluate surface sheet flow patterns, depths, and velocities; (3) evaluate the concentrated channelized flow patterns, depths and velocities; (4) evaluate the impacts of flood-induced shifts on the locations of channels; (5) simulate construction of the project and determine the magnitude of the changes in the overall infiltration rates, surface sheet flow, and channel flow; and (6) evaluate mitigation measures for potential project impacts.

The random phenomenon of stormwater paths will be superimposed on the mostly deterministic distribution of two-dimensional flow on the alluvial fan. That superposition will be consistent with both the mapping of historically active channel (as delineated within the hydrogeologic assessment) and the guidelines described by the Federal Emergency Management Agency (2000), the National Research Council (1999), and the Clark County hydrology manual (Clark County Regional Flood Control District, 1999).

The limits of the HEC-1 and Flo-2D models are shown on Figure 1. The development of the HEC-1 and Flo-2D models is discussed below and preliminary results are presented.

HEC-1 MODELING OF THE MOUNTAIN WATERSHEDS

Flood flows from the mountain watersheds west of the project site were calculated using the HEC-1 rainfall-runoff model. Flow hydrographs have been calculated for the 100-year storm. Flow hydrographs will also be calculated for the 10-year and 50-year storm events. The HEC-1 model is capable of simulating runoff using a number of different methods. For this study, the models were created based on the SCS Unit Hydrograph Method, which is one of four methods adopted for use by the Clark County Hydrologic Criteria and Drainage Design Manual (Clark County Manual). For the SCS Unit Hydrograph Method, the following information must be provided as model input: watershed area, rainfall data, infiltration data, and watershed lag time. This data is discussed below.

Watershed Area

Flow hydrographs were calculated for 15 mountain watersheds that discharge to the alluvial fan area at distinct locations. The watershed limits were determined using USGS topographic

mapping and are shown on Figure 1. The total area covered by the mountain watersheds is approximately 13,900 acres. The areas of individual watersheds varied from 211 to 3,220 acres. The area for each of the watersheds is listed on Table 1.

Table 1. Hydrologic Data for the Mountain Watersheds

Watershed	Area, ac	100-Year, 24-Hour Rainfall		Lag Time, hr	Curve Number
		Data from NOAA Atlas 14	With Areal Reduction		
M1	870	3.57	3.18	0.26	83
M2	501	3.69	3.28	0.20	88
M3	442	3.71	3.30	0.21	81
M4	3220	3.99	3.55	0.37	87
M5	269	3.88	3.45	0.27	88
M6	211	4.13	3.68	0.20	88
M7	418	4.07	3.62	0.26	88
M8	777	4.07	3.63	0.28	88
M9	742	4.30	3.83	0.28	88
M10	748	4.05	3.61	0.34	86
M11	2244	4.42	3.93	0.41	88
M12	803	4.10	3.65	0.34	84
M13	1270	4.27	3.80	0.36	86
M14	519	4.05	3.60	0.24	84
M15	835	3.97	3.53	0.29	85

Precipitation

A storm duration of 24-hours was used for this study. The total rainfall depths for the three storm frequencies were determined using NOAA Atlas 14. NOAA Atlas 14 replaces NOAA Atlas 2, which is referenced for use by the Clark County Manual. Precipitation totals vary across the watersheds and ArcGIS was used to determine the average rainfall depth for each watershed. A depth area reduction factor of 0.89 was determined using NOAA Technical Memorandum NWS Hydro 40 as required by Clark County. This reduction factor was applied to the depths obtained from NOAA Atlas 14. The rainfall totals are distributed over time using the SCS Type II distribution. The precipitation depths used for each watershed are summarized on Table 1.

Infiltration

Precipitation losses are calculated by the HEC-1 model using SCS Curve Number approach. Curve Numbers (CN) are based on the soil and cover types that compose a watershed. Soil types within each watershed were determined from the latest soil survey by the Natural Resources

Conservation Service (NRCS). For each soil type, the NRCS assigns one of four Hydrologic Soil Type classifications based on the soil's potential to infiltrate rainfall. Type A has the highest, and Type D the lowest infiltration potential, with Types B and C in between. Figure 2 shows the soil types found within the study area. A list of the soil types within the study area is presented in Table 2 along with the associated Hydrologic Soil Type and Curve Number. The Curve Number for a given Hydrologic Soil Type is based on the values presented in the Clark County Manual. The calculated CN values for each watershed are summarized on Table 1. Detailed calculations of CN values for each watershed are presented on Table 3.

Table 2. Soil Types and Curve Numbers

Soil Type	Hydrologic Soil Group	Cover	Condition	Curve Number (CN)
Arizo loamy sand, 2 to 8 percent slopes	A	Semi-Arid Rangeland	Poor	63
Colosseum Association, 2 to 4 percent slopes	A	Semi-Arid Rangeland	Poor	63
Copper World Association 30 to 60 percent slopes	D	Semi-Arid Rangeland	Poor	88
Copperworld-Lithic Ustic Haplargids association, 30 to 60 percent slopes	D	Semi-Arid Rangeland	Poor	88
Lithic Ustic Haplocalcids gravelly sandy loam, 30 to 60 percent slopes	D	Semi-Arid Rangeland	Poor	88
Popups sandy loam, 4 to 30 percent slopes	B	Semi-Arid Rangeland	Poor	77
Umberci-Rock outcrop association, 30 to 75 percent slopes	D	Semi-Arid Rangeland	Poor	88
Unclassified	D	Semi-Arid Rangeland	Poor	88 (Assumed)

Lag Time

Watershed lag times are based on the following equation from the Clark County Manual:

$$\text{Lag Time} = 20\ K_n\ (L\ L_c / S^{0.5})^{0.33}$$

Where:

K_n = Manning's Roughness Factor for the Basin Channels
L = Length of Longest Watercourse (mi)
L_c = Length Along Longest Watercourse Measured Upstream to a Point Opposite the Centroid of the Basin (mi)
S = Average Slope of the Longest Watercourse (ft per mi)

Table 3. Curve Numbers Calculations for Mountain Watersheds

Soil Type	Hydrologic Soil Type	Soil Type CN	Soil Type Areas by Watershed, acres														
			M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15
Arizo loamy sand, 2 to 8 percent slopes	A	63			118	95											41
Colosseum Association, 2 to 4 percent slopes	A	63	166														
Copper World Association, 30 to 60 percent slopes	D	88											260	442	463	253	645
Copperworld-Lithic Ustic Haplargids association, 30 to 60 percent slopes	D	88				1,063						82	200	38	481	90	26
Lithic Ustic Haplocalcids gravelly sandy loam, 30 to 60 percent slopes	D	88											130		146		
Popups sandy loam, 4 to 30 percent slopes	B	77				134						138	100	323	180	176	123
Umberci-Rock outcrop association, 30 to 75 percent slopes	D	88	704	501	324	1,119											
Unclassified	D	88				809	269	211	418	777	742	528	1,554				
Total Area, acres			870	501	442	3,220	269	211	418	777	742	748	2,244	803	1,270	519	835
Composite CN			83	88	81	87	88	88	88	88	88	86	88	84	86	84	85

The calculated lag times for each watershed are summarized on Table 1. Detailed lag time calculation data are presented on Table 4.

Table 4. Lag Time Calculations

Watershed	Kn	L, mi	Lc, mi	Elevation at Upstream end of Watershed, feet, NGVD29	Elevation at Downstream end of Watershed, feet, NGVD29	Slope, ft/mi	Lag Time, hr
M1	0.03	1.89	0.90	4140	3240	476.2	0.26
M2	0.03	1.35	0.80	4950	3600	1000.0	0.20
M3	0.03	1.73	0.70	5080	3550	884.4	0.21
M4	0.03	3.32	1.50	5420	3800	488.0	0.37
M5	0.03	1.86	1.30	5280	3820	784.9	0.27
M6	0.03	1.52	0.70	5310	3980	875.0	0.20
M7	0.03	2.06	1.20	5960	3930	985.4	0.26
M8	0.03	2.25	1.30	5960	3970	884.4	0.28
M9	0.03	2.49	1.00	5960	4240	690.8	0.28
M10	0.03	3.07	1.50	5750	3760	648.2	0.34
M11	0.03	4.42	2.20	7850	3700	938.9	0.41
M12	0.03	2.8	1.50	5230	3780	517.9	0.34
M13	0.03	4.22	1.50	7150	3130	952.6	0.36
M14	0.03	1.75	1.00	5210	3720	851.4	0.24
M15	0.03	2.35	1.20	5030	3510	646.8	0.29

HEC-1 Results

Flood flow calculations for the mountain watersheds have been completed for the 100-year storm event. A summary of the calculated peak flow and runoff volume for each watershed is provided on Table 5.

Table 5. Summary of Results for HEC-1 Modeling

Watershed	Area, acres	Peak Flow, cfs	Total Runoff, in
M1	870	1,299	1.59
M2	501	1,102	2.07
M3	442	713	1.55
M4	3220	5,518	2.23
M5	269	550	2.22
M6	211	544	2.43
M7	418	930	2.38
M8	777	1,672	2.39
M9	742	1,717	2.57
M10	748	1,328	2.20
M11	2244	4,290	2.66
M12	803	1,339	2.07
M13	1270	2,346	2.37
M14	519	1,021	2.02
M15	835	1,508	2.04

FLO-2D MODELING OF ALLUVIAL FAN AREA

A hydrologic and hydraulic model of the alluvial fan area, including the proposed project site, was created using the Flo-2D two dimensional hydraulic model. The limits of the Flo-2D model are shown on Figure 1. To create the Flo-2D model, the study area was divided into a grid and the hydraulic and hydrologic data for each grid element was assigned. Typical grid element data included: elevation, rainfall depth, rainfall distribution, infiltration data, and Manning's roughness coefficient. Once the grid data was defined, well defined channels that are large enough to carry significant flows were superimposed on the grid. The development of the various input data is described below.

Grid Elevations

The study area was divided into 200'x200' grid elements. This resulted in nearly 19,000 grid elements over an area covering approximately 17,300 acres. The average elevation of each grid element was determined using the detailed topographic mapping for the project site, developed by Airborne 1, in combination with a 10 meter Digital Elevation Model (DEM) obtained from the USGS. The topographic data was used by the Flo-2D model to determine the average elevations within each grid element.

Rainfall and Infiltration Data

The rainfall and infiltration data for the grid elements were developed using the same data and approach that were used for the mountain watersheds. Rainfall data was obtained from NOAA Atlas 14 and was distributed over time using the SCS Type II distribution. Infiltration rates are calculated by the model using the SCS Curve Number approach. Curve Numbers were assigned based on the soil types and associated Hydrologic Soil Groups. Curve numbers were assigned to individual grid elements based on the soil types shown on Figure 2 and the Curve Numbers presented on Table 2.

Manning's Roughness Coefficient

Manning's roughness coefficients were assigned based review of the site conditions in the field, review of the Clark County Manual, and engineering judgment. For overland flow across the desert terrain, a roughness coefficient of 0.07 was used. This is appropriate for the relatively shallow overland flow depths through the typical desert vegetation. For channels, a value of 0.04 was used. A lower value for the channels is appropriate because flow depths will be larger and channels contain less vegetation. These selected roughness coefficients values are consistent with the recommend values on Table 710 of the Clark County Manual.

Channel Modeling

Flood flows in active alluvial fans can be conveyed as a combination of sheet flow and channel flow. Channel flow is typically characterized by shallow, braided channels with flow paths that area unstable and random. As a preliminary assessment of the potential flooding hazard at the project site, significant channels were included in the Flo-2D model in their current locations. The location and size of existing channels were determined from field measurements, topographic mapping, aerial photographs, and the Delineation of the Waters of the U.S. by CH2MHill. The CH2MHill study identified 5 classes of ephemeral washes within the project site based on channel width. For this study, channels that were in Classes 1 through 3 were included in the model. This included any channel that was greater than 10 feet in width. Due to the large size of the study area, it was not possible to verify the channel sizes identified by CH2MHill or to measure all channels outside the project area. Therefore, the channel sizes are approximate, but are adequate for developing a general understanding of the potential site flooding. The locations of channels that are included in the Flo-2D are identified on Figures 3 and 4 as "Modeled Ephemeral Channels".

Flo-2D Results

A preliminary model run was made for the 100-year storm event. Figures 3 and 4 present the calculated peak flood depths and velocities. As Figure 3 shows, the maximum flood depths are generally 0.5 feet or less. Larger depths of up to 2 feet are predicted along the modeled channels and along paths of significant flow concentrations such as the northern side of the Ivanpah 1 and Ivanpah 3 sites.

Figure 4 shows that peak 100-year velocities are generally 3.5 feet per second or less. Higher velocities are predicted within the channels. The highest velocities occur at the locations where runoff from the mountain watersheds is discharged to the alluvial fan. The velocities are generally reduced as the flow spreads out as sheet flow or splits into multiple channels.

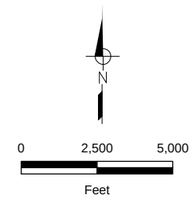
The Flo-2D model will calculate flow hydrographs at user selected locations of the floodplain. At these floodplain sections, the model sums the flow at each grid element included in the section. This will be useful to track the potential changes in flow caused by construction of the project. For this preliminary analysis, three flow hydrographs were developed for 3 floodplain sections. Figure 5 shows the locations of the floodplain sections and Figure 6 presents the calculated hydrographs at each section. It can be seen from Figure 6 that the majority of the flood flow passes through the Ivanpah 1 and Ivanpah 3 sites at the south and north ends of the project, respectively. A much smaller flow volume passes through the center of the project. This is logical because the mountain watersheds discharge flow to the center of the project site are relatively small compared to the watershed areas that discharge flow towards the north and south ends of the project.

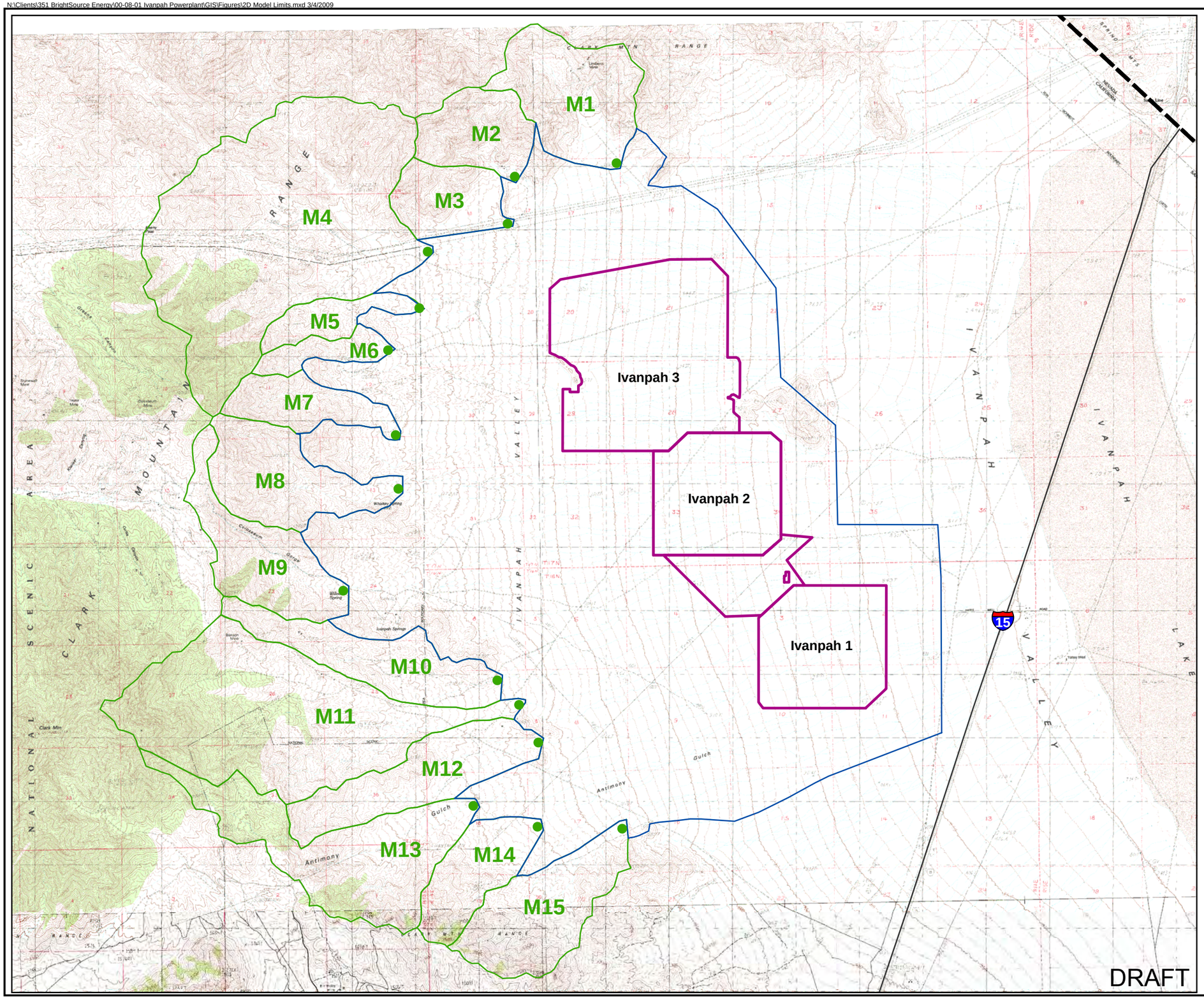
N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\2D Model Limits.mxd 3/4/2009

FIGURE 1

BrightSource Energy
Ivanpah Solar Electric Generating System

Hydrologic and Hydraulic Model Limits





LEGEND

- Approx. Project Limits
- Flo-2D Model Limts
- HEC-1 Watersheds
- HEC-1 Flow Concentration Point

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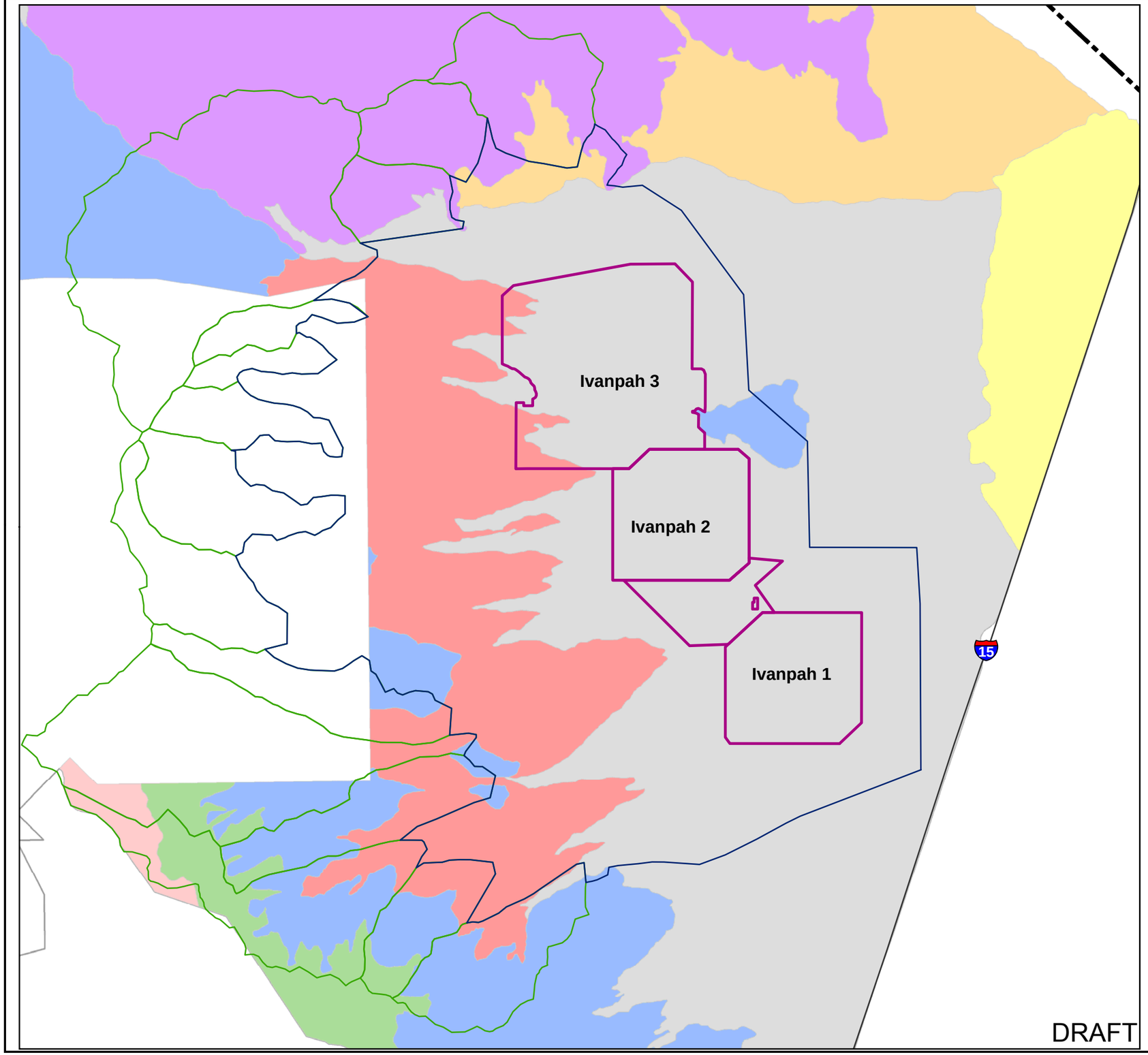
N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\Storm Figure 2 - Soil Types.mxd 3/4/2009

FIGURE 2

BrightSource Energy
Ivanpah Solar Electric Generating System

NRCS Soil Classifications



N

0 2,500 5,000

Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- HEC-1 Watershed Boundary

NRCS Soil Classification

- Arizo loamy sand, 2 to 8 percent slopes
- Colosseum Association, 2 to 4 percent slopes
- Copperworld association, 30 to 60 percent slopes
- Copperworld-Lithic Ustic Haplargids association, 30 to 60 percent slopes
- Lithic Ustic Haplocalcids gravelly sandy loam, 30 to 60 percent slopes
- Popups sandy loam, 4 to 30 percent slopes
- Typic Haplosalids, 0 to 2 percent slopes
- Umberci-Rock outcrop association, 30 to 75 percent slopes
- Unclassified

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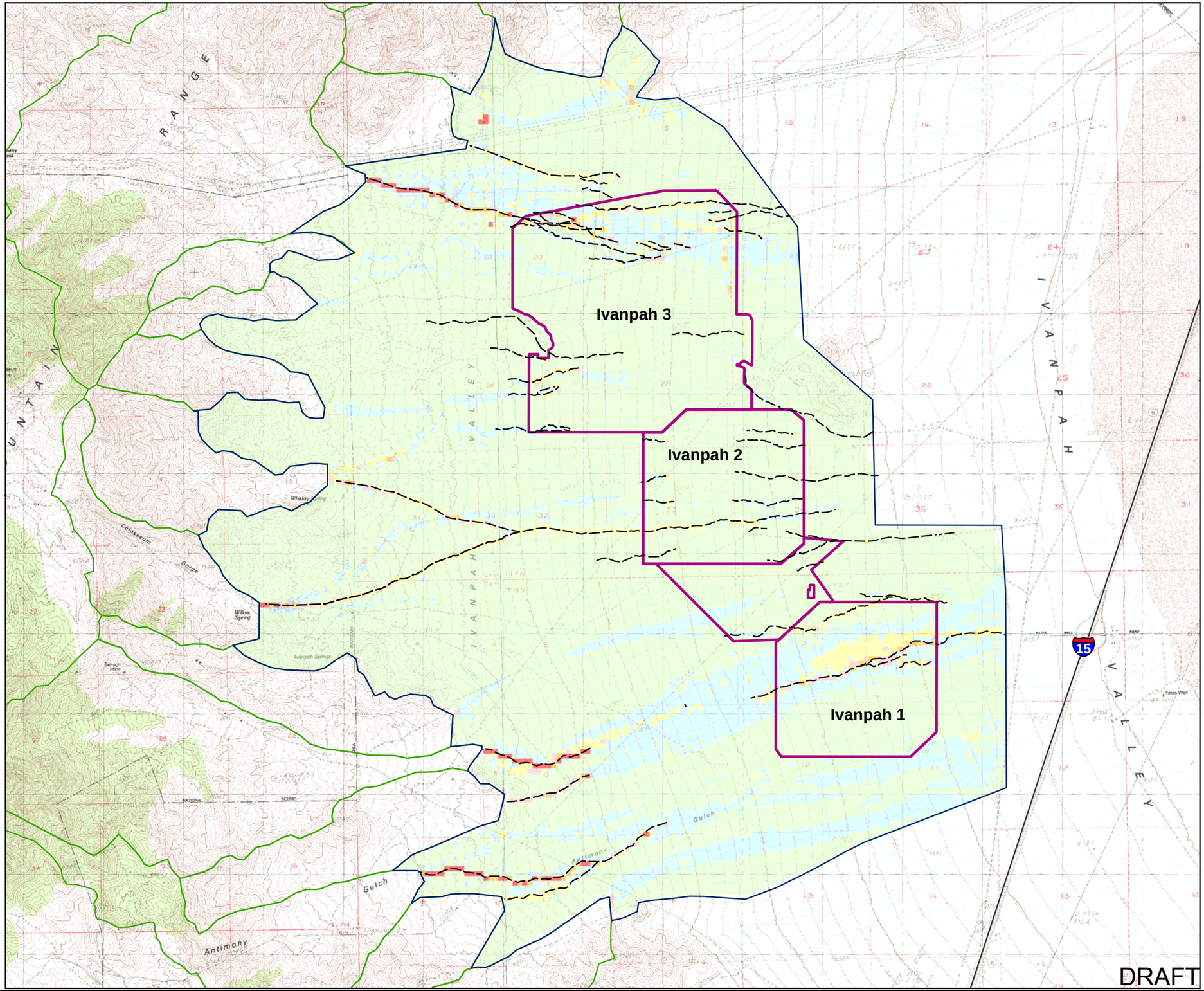
N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\Flood Depths.mxd 3/4/2009

FIGURE 3

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flood Depths



N

0 2,000 4,000

Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- HEC-1 Watershed Boundary
- Modeled Ephemeral Channels

100-Year Flow Depth

- 0.0' - 0.5'
- 0.5' - 1.0'
- 1.0' - 1.5'
- 1.5' - 2.0'
- 2.0' - 2.5'
- >2.5'

WEST YOST ASSOCIATES
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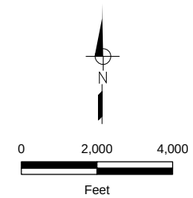
DRAFT

N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\Flow Velocities.mxd 3/4/2009

FIGURE 4

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flow Velocities



Ivanpah 3

Ivanpah 2

Ivanpah 1

LEGEND

- Approx. Project Limits
- 2D Model Limts
- HEC-1 Watershed Boundary
- Modeled Ephemeral Channels

Flow Velocity (feet per second)

- 0.0 - 3.5
- 3.5 - 7.0
- 7.0 - 10.5
- 10.5 - 14.0
- 14.0 - 17.6

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N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\Storm Figure 5 - Cross Section Locations.mxd 3/4/2009

FIGURE 5

BrightSource Energy
Ivanpah Solar Electric Generating System

Floodplain Cross Section Locations

Ivanpah 3

Ivanpah 2

Ivanpah 1

Section 1

Section 2

Section 3

N

0 1,500 3,000
Feet

LEGEND

- Floodplain Section Locations
- Approx. Project Limits
- 2D Model Limts

DRAFT

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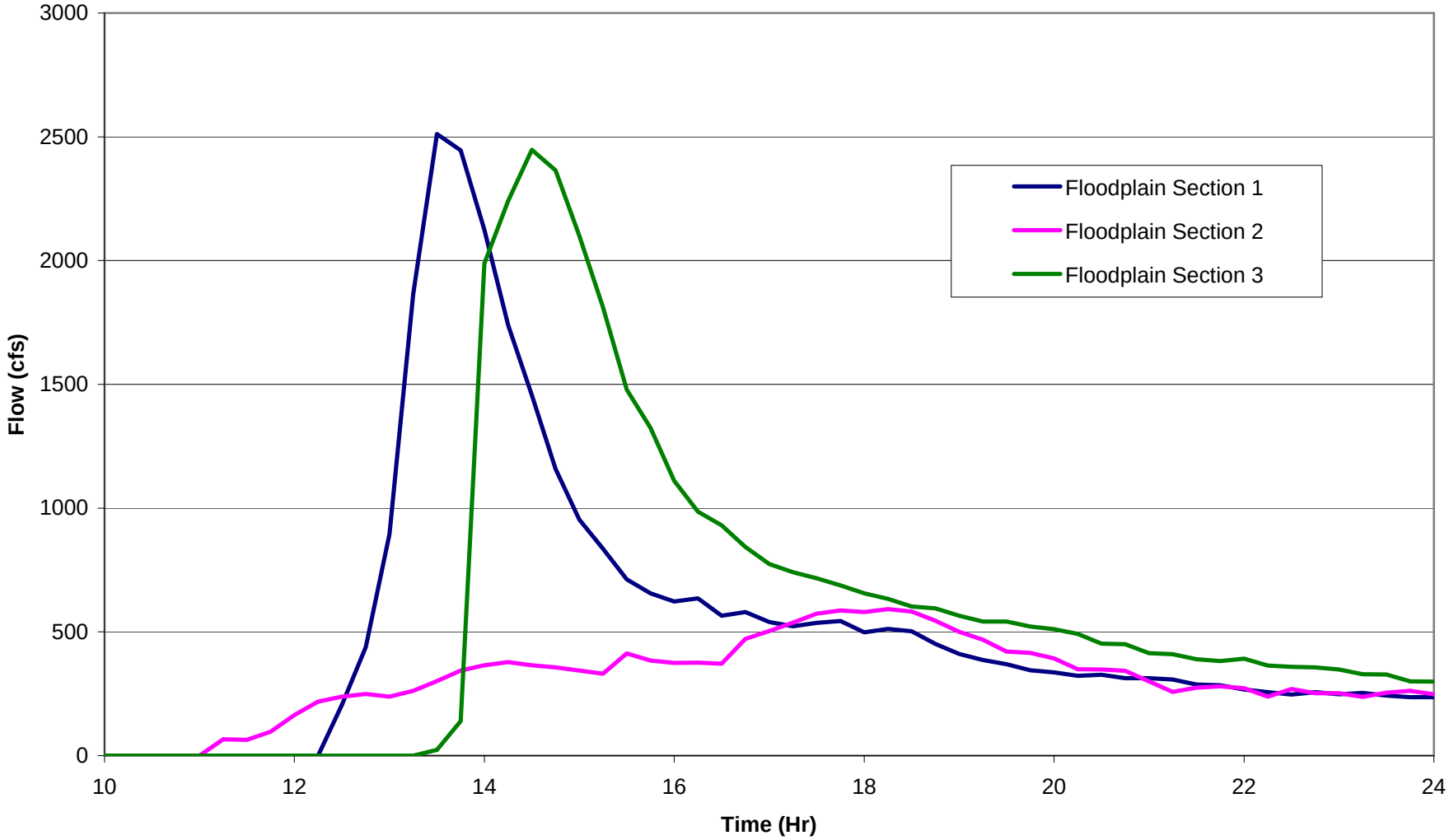
FIGURE 6
Pre-Project 100-Year Flow Hydrograph at Floodplain Cross Sections



WEST YOST ASSOCIATES

TECHNICAL MEMORANDUM NO. 6

DATE: March 24, 2009 Project No.: 351-00-08-01.004

TO: BrightSource Energy, Inc.

FROM: Mark Kubik, R.C.E. #50963

SUBJECT: ISEGS Stormwater—Preliminary Flo-2D Modeling for Post-Project Conditions

INTRODUCTION

West Yost Associates is performing a study to define the potential flooding conditions at the proposed Ivanpah Solar Electric Generating System (ISEGS). The goals of the overall study are to establish the pre-project flooding conditions at the site; determine the potential impacts of the proposed project; and evaluate mitigation measures for the identified impacts. Technical Memorandum No. 2, March 2, 2009 (TM No. 2) documents the preliminary results for pre-project conditions. This technical memorandum presents the preliminary analysis of post-project flooding conditions at the project site and identifies potential impacts on flood flows. The analysis performed to-date is limited to the 100-year storm event. The principal purpose of this memorandum is to describe the approach to the analysis, to describe the preliminary results, and to solicit comments on the approach and results.

APPROACH

As discussed in TM No. 2, the modeling approach for the ISEGS stormwater analysis is to use of the HEC-1 computer program to calculate runoff hydrographs from the mountain watersheds and to use the Flo-2D model to calculate runoff from the alluvial fan area. The Flo-2D model is also used to route the combined mountain and alluvial fan runoff across the floodplain and within the channels.

For the evaluation of post-project conditions, a number of changes were made to the Flo-2D model. The changes include adjustments to the SCS Curve Numbers at the project site to reflect changed infiltration rates due to construction of paved roads, compacted earth or gravel roads, parking areas, buildings, and other structures. Additionally, ground surface elevations in some areas were modified to reflect construction of pads or embankments to protect structures from floodwaters. Specific changes to the Flo-2D model are described below.

Changes to Flo-2D model for post-project conditions

The changes to the Flo-2D model for individual elements of the proposed project are described below.

Mirror Arrays

Each of the three solar-concentrating thermal power plants will include an array of mirrors that will focus the solar energy on boilers located on a central tower. The mirrors will be mounted on heliostats, which will consist of a pole embedded in the ground and structures that will attach two mirrors to each pole. The heliostats will be arranged in circumferal rows around the central towers with spacing within a row of about 18 feet and spacing between rows of about 25 feet. Unpaved service pathways will be located between the heliostat rows to allow access for maintenance and cleaning. The vehicle traffic along the pathways will compact the ground surface resulting in a reduction in infiltration capacity along the path. Technical Memorandum No. 4 presents a detailed analysis of the effects of the mirror arrays and service paths on soil infiltration rates. That analysis indicated that construction of the mirror arrays could cause an increase in runoff volume of approximately 10 percent during a flood event. To reflect this potential increase, the SCS Curve Numbers in the Flo-2D model were adjusted upward. Table 1 presents the adjustments made for each of the two Hydrologic Soil Types found within the project area.

Table 1. Curve Number Adjustments for Mirror Array Areas

Item	Hydrologic Soil Type A		Hydrologic Soil Type B	
	Pre-Project	Post-Project	Pre-Project	Post-Project
Curve Number	63	64.3	77	79
Rainfall, in	3.2	3.2	3.2	3.2
Runoff, in	0.52	0.57	1.21	1.34
Runoff Increase, %	—	10.0	—	10.0

Most of the area covered by the mirror arrays will be ungraded. It is likely that the northern portion of Ivanpah 3 will be graded. Approximately 160 to 170 acres are currently anticipated to be graded. For this analysis, it was assumed that the grading will not significantly change the infiltration capacity from that of the ungraded mirror areas. Therefore, the same Curve Number is used for both the graded and ungraded areas.

Power Block and Substation Areas

Power blocks will be constructed at the center of each of the mirror arrays. The power blocks will house the boiler, air emission control system, generator, condenser, waste water treatment equipment, auxiliary equipment, and a water tank. The power blocks will be protected from flooding by embankments, fill, or a combination of the two. For the Flo-2D modeling, it was assumed that the power block sites would be filled above the floodplain water surface elevations and the Flo-2D grid elements covering the power block areas were raised accordingly. The Curve Numbers were also adjusted upward to reflect the reduced infiltration due to an increase in impervious area. It was assumed for this preliminary analysis that 60 percent of the power block areas would covered by impervious surfaces. To account for this, the SCS Curve Numbers for the power block areas were increased from 63 to 85.

A substation is proposed to be constructed in the common area between the Ivanpah 1 and Ivanpah 2 sites. The same set of assumptions used for the Power Block areas were applied to the substation site. The site is assumed to be raised above the floodplain elevations and the Curve Number at the site is increased from 63 to 85.

Administration and Storage Building

An administration and storage building is proposed in the common area. This building and the associated parking were assumed to be completely impervious (Curve Number of 98) and raised above the floodplain elevations.

Roadways

There are other access roads besides those between the heliostat rows that are proposed for construction. Some of the roads will be dirt or gravel and some will be paved. The roads are assumed to be 12 feet wide. For this preliminary analysis, each grid element that contained a dirt or gravel road, the curve number was increased to produce a 10 percent increase in runoff based on the discussion above for the mirror array areas. This is very conservative because the width of an individual grid element in the Flo-2D model is 200 feet. Therefore, a road that is 12 feet wide covers 6 percent of the grid. For the heliostat areas, the service paths will cover approximately 32 percent of the area. Because the gravel roads cover an extremely small percentage of the entire project site, an over-estimation of runoff volume from them will not significantly change the results of the model. Paved roads were treated as completely impervious (Curve Number of 98).

Flo-2D Results

A preliminary model run was made for the post project 100-year storm event and the results have been compared to those for the pre-project analysis. Figures 1 and 2 present the calculated peak flood depths in the vicinity of the project for pre-project and post-project conditions, respectively. The flood depths are similar for the two conditions, but changes in depth are predicted a few locations within and downstream of the project site. Figure 3 shows the estimated changes in flow depths due to construction of the project. The most significant increases in 100-year flood depths occur within the project site at the upstream side of the power blocks and substation. For this modeling effort it was assumed that these facilities will be raised and flows will be diverted around them. Other flood protection measures may be implemented such as embankments and diversion channels. It is anticipated that use of other measures would not produce significant changes from the results presented herein.

Downstream of the project, there are some locations where flow depths will increase up to a maximum of about 0.20 feet. The locations are relatively few and scattered with the exception of the area downstream of the common area between Ivanpah 1 and 2. Depth increases are predicted along an existing ephemeral wash for about 2,800 feet downstream of the project. However, the maximum depth increase along this path is relatively small, ranging from 0.11 to 0.20 feet.

Flow hydrographs were created across five floodplain sections for both pre-project and post-project conditions. Figure 4 shows the locations of the floodplain sections and Figures 5 through 9 present the calculated hydrographs at each section. The flow hydrographs across Ivanpah 1 and northern Ivanpah 3 are presented on Figure 5 and Figure 9. As those two figures show, the peak flows across these portions of the floodplain are relatively large at just under 2,500 cfs. The post-project flows at these two locations are essentially unchanged from pre-project conditions. This is because over 80 percent of the flows from the mountain watersheds pass across these sections of the floodplain and the additional runoff due to the project represents a very small percentage of the total flow.

The flow hydrographs at the remaining three floodplain sections adjacent to the Ivanpah 2, southern Ivanpah 3, and the common area are shown on Figures 6 through 8. The peak flows across these floodplain sections are relatively small ranging from approximately 160 cfs to 400 cfs. At these locations, the runoff from the project site contributes a larger percentage of the total flow and therefore, development of the project will has a more discernable effect at these locations. Table 2 provides a summary of the project's effects on flows across the five floodplain sections.

Table 2. Floodplain Flows – Pre-Project versus Post-Project

Section	Peak Flow, cfs			Runoff Volume, ac-ft		
	Pre-Project	Post-Project	Change, %	Pre-Project	Post-Project	Change, %
1	2448	2383	-2.7%	701	700	0.0%
2	257	285	10.9%	184	189	3.2%
3	382	395	3.3%	195	201	2.7%
4	162	179	10.2%	74	76	2.7%
5	2557	2575	0.7%	558	556	-0.2%

Peak velocities have also been calculated and compared. Figures 10 and 11 present the calculated peak flow velocities for pre-project and post-project conditions, respectively. Figure 12 shows the estimated changes in flow velocities due to construction of the project. The changes to peak velocities are similar to the changes in flow depth. The largest changes are within the project site near the facilities that will be protected from flooding and will require flood flows to be re-routed. Off-site increases are mostly limited to a few locations downstream of Ivanpah 2 and the common area between Ivanpah 1 and 2.

MOK:mal

N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 1 - 100-Year Flood Depths - Site Existing.mxd 3/23/2009

FIGURE 1

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flood Depths
Existing Condtions

Ivanpah 3

Ivanpah 2

Ivanpah 1

N

0 1,250 2,500
Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- Modeled Ephemeral Channels

Flow Depth

- 0.0' - 0.5'
- 0.5' - 1.0'
- 1.0' - 1.5'
- 1.5' - 2.0'
- 2.0' - 2.5'
- >2.5'

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N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 2 - Flood Depths PP Site.mxd 3/23/2009

FIGURE 2

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flood Depths
Post-Project

Ivanpah 3

Ivanpah 2

Ivanpah 1

N

0 2,000 4,000
Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- Modeled Ephemeral Channels

Flow Depth

- 0.0' - 0.5'
- 0.5' - 1.0'
- 1.0' - 1.5'
- 1.5' - 2.0'
- 2.0' - 2.5'
- >2.5'

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N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 3 - Flood Depth Change PP100.mxd 3/23/2009

FIGURE 3

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flood Depth Changes Post-Project

Ivanpah 3

Ivanpah 2

Ivanpah 1

VALLEY

IVANPAH

T17N

T16N

N

0 1,250 2,500

Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- Modeled Ephemeral Channels

Flood Depth Change

- -0.61' - 0.09'
- 0.10' - 0.20'
- 0.21' - 0.40'
- 0.41' - 0.60'
- 0.61' - 0.80'
- 0.81' - 1.00'
- 1.01' - 1.20'
- 1.21' - 1.40'
- 1.41' - 1.60'

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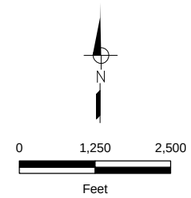
N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 4 - Cross Section Locations.mxd 3/20/2009

FIGURE 4

BrightSource Energy
Ivanpah Solar Electric Generating System

Floodplain Cross Section Locations



Ivanpah 3

Ivanpah 2

Ivanpah 1

Section 5

Section 4

Section 3

Section 2

Section 1

LEGEND

- Floodplain Section Locations
- Approx. Project Limits
- 2D Model Limts

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FIGURE 5
Floodplain Section 1 - 100-Year Flow Hydrographs

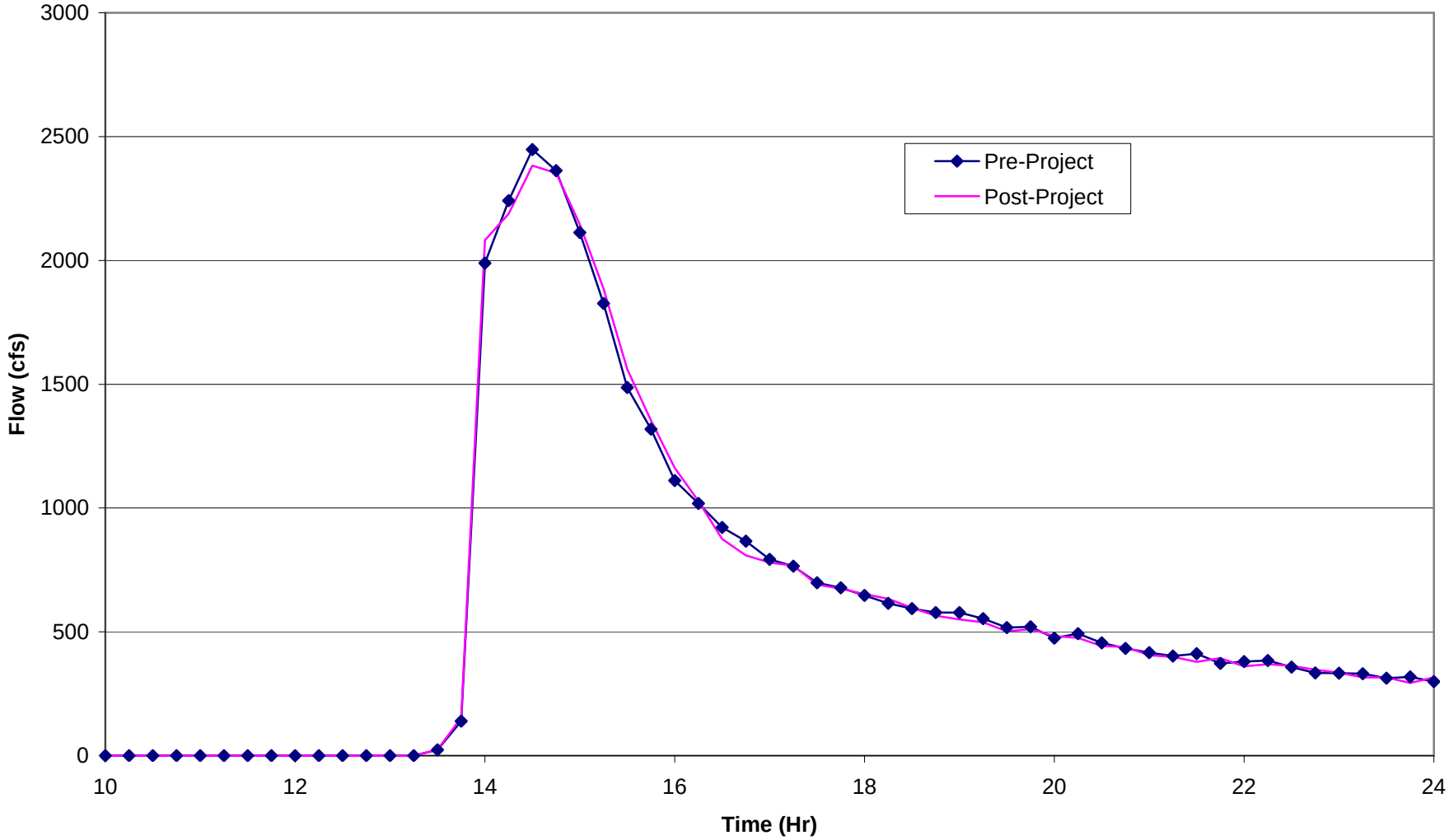


FIGURE 6
Floodplain Section 2 - 100-Year Flow Hydrographs

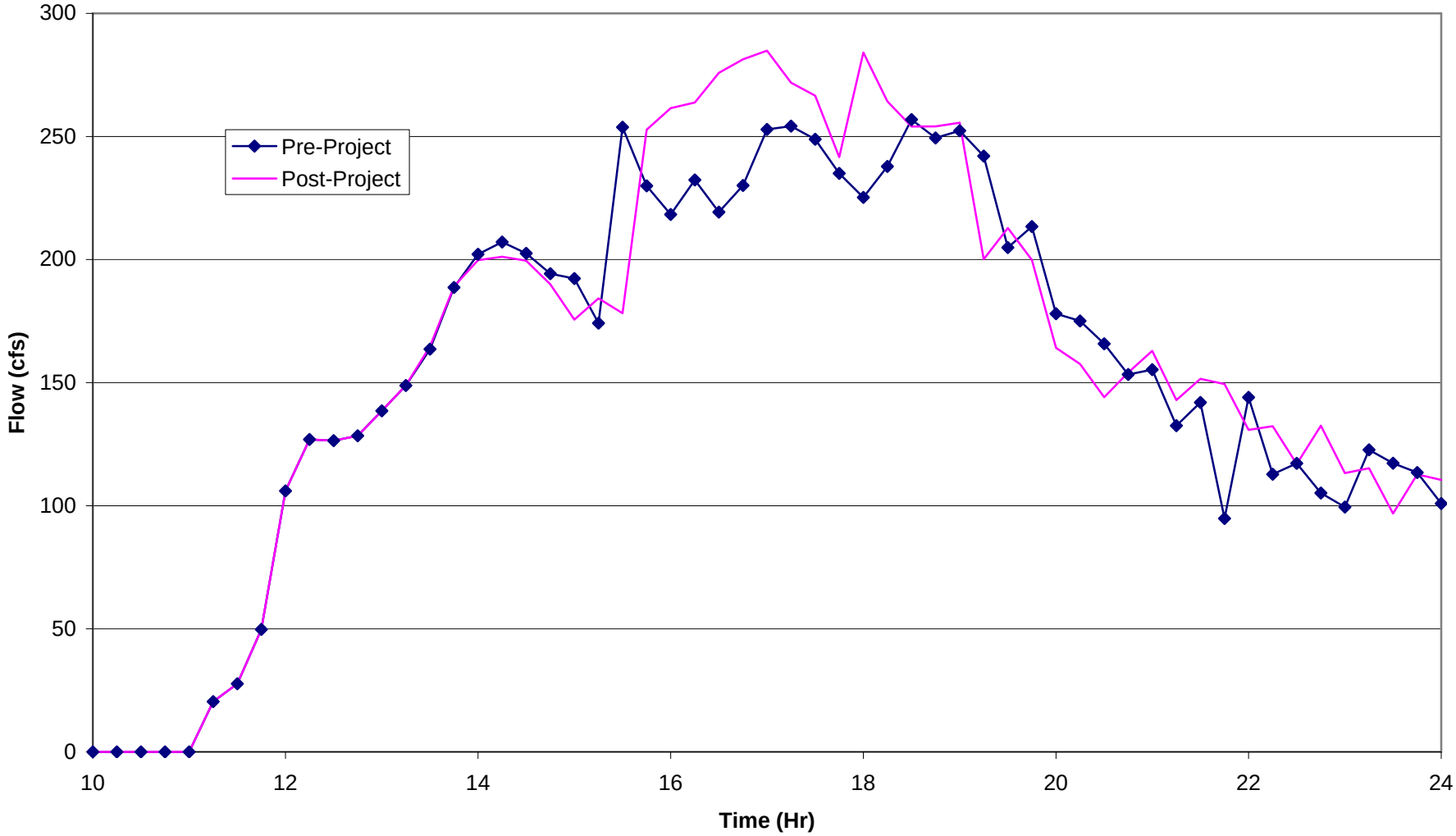


FIGURE 7
Floodplain Section 3 - 100-Year Flow Hydrographs

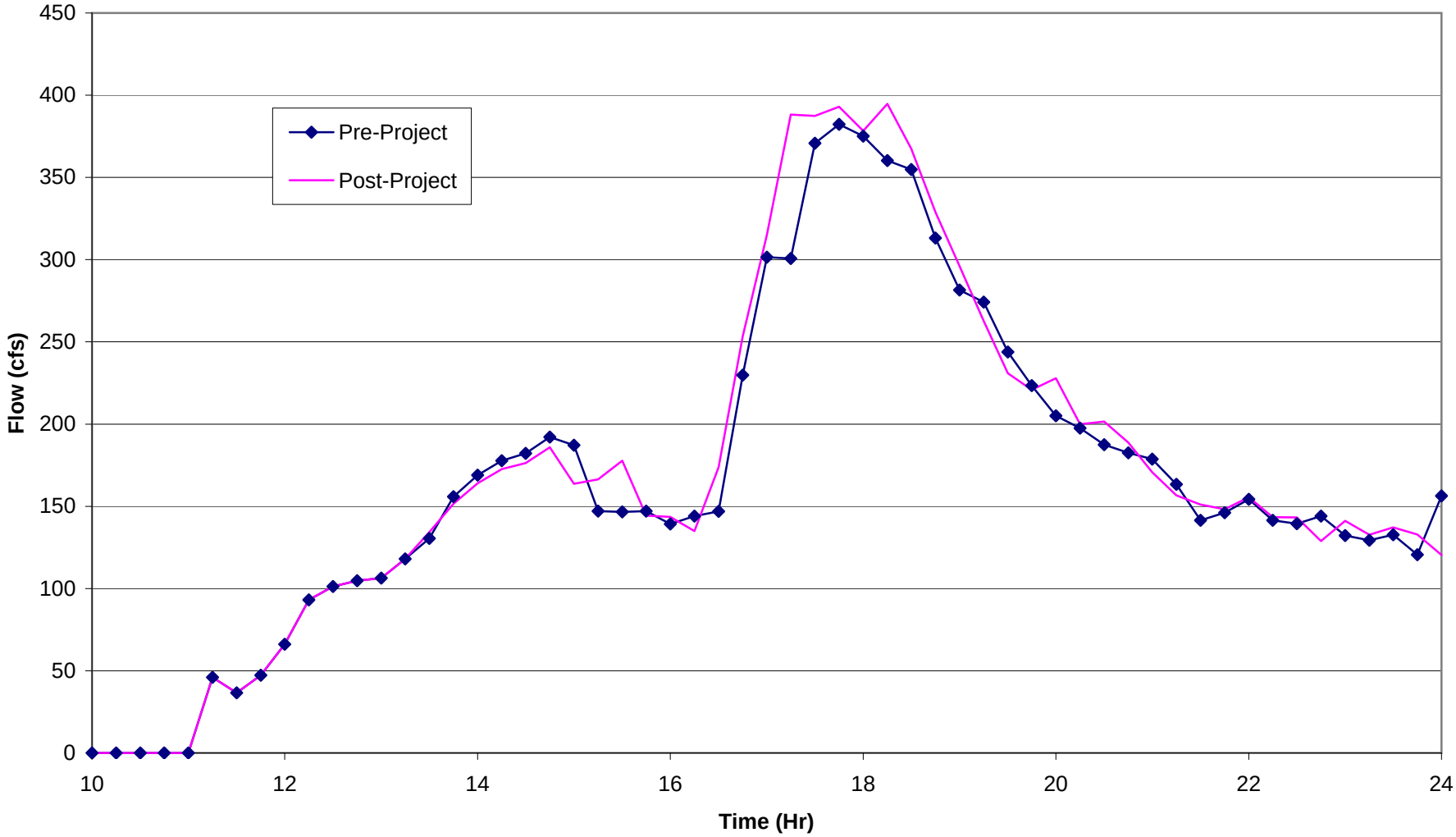


FIGURE 8
Floodplain Section 4 - 100-Year Flow Hydrographs

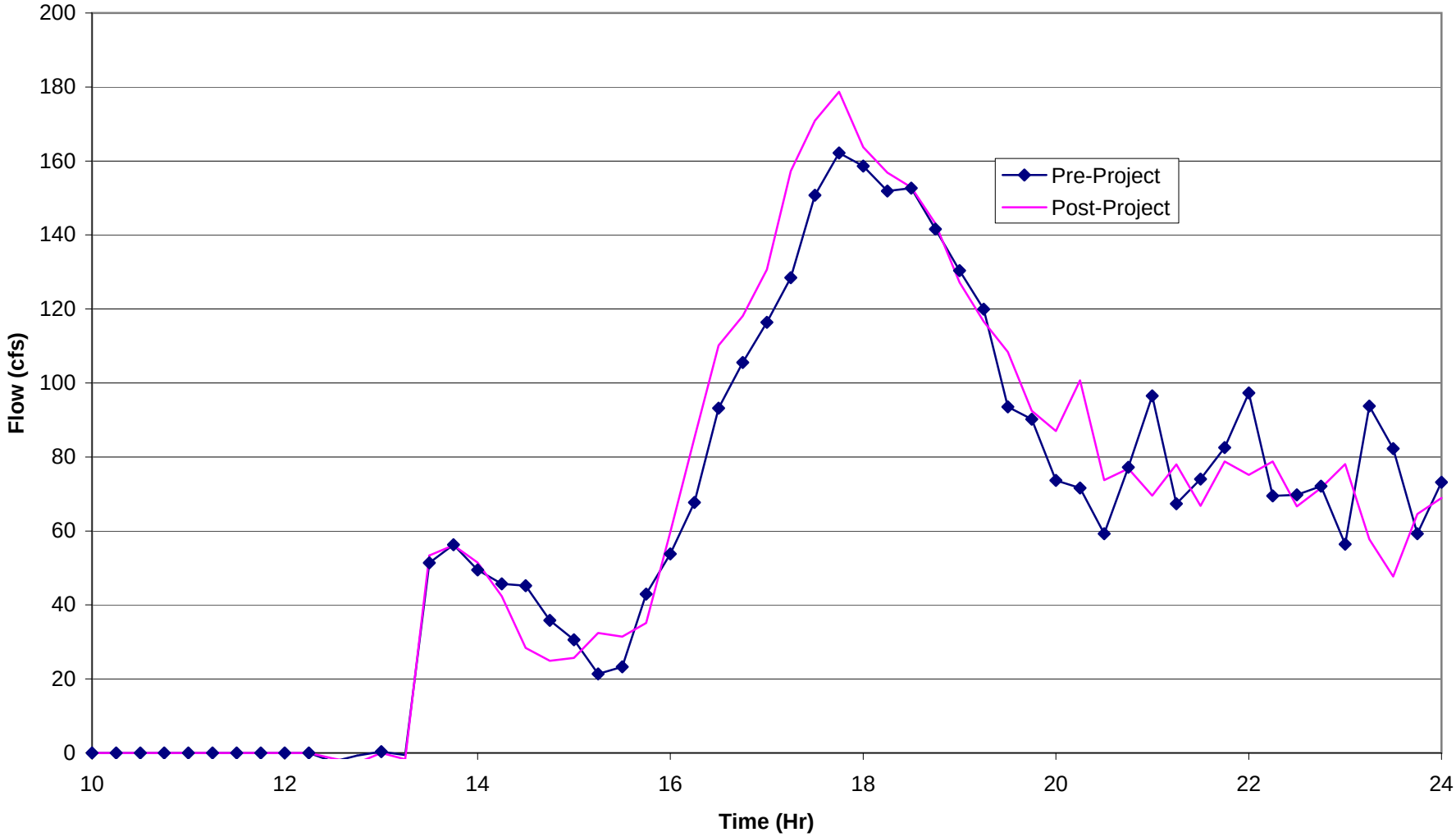
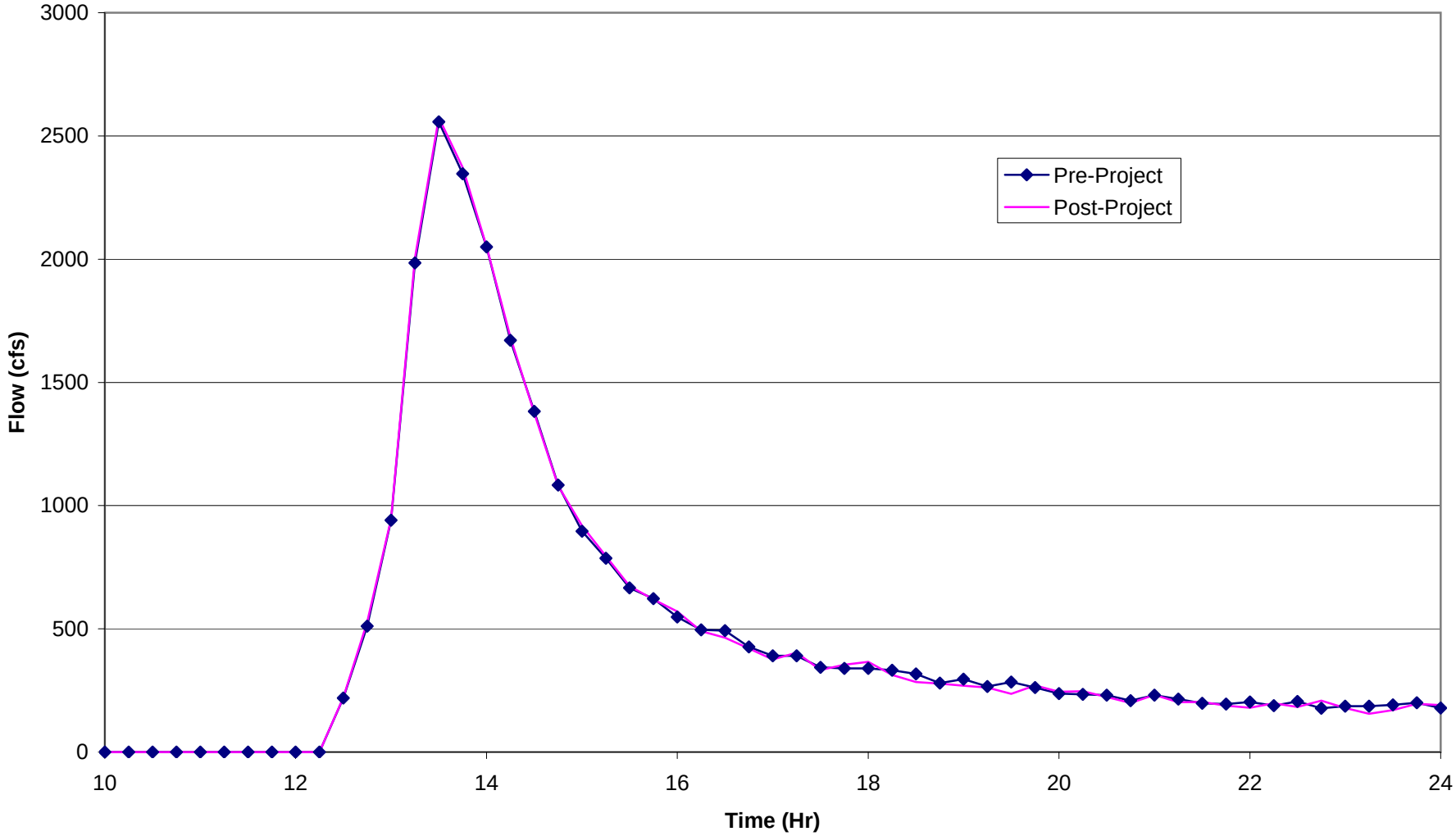


FIGURE 9
Floodplain Section 5 - 100-Year Flow Hydrographs



N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 10 - 100-Year Flow Velocities - Site Existing.mxd 3/20/2009

FIGURE 10

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flow Velocities
Existing Conditions

Ivanpah 3

Ivanpah 2

Ivanpah 1

VALLEY

IVANPAH

N

0 1,250 2,500
Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- HEC-1 Watershed Boundary
- Modeled Ephemeral Channels

Flow Velocity (fps)

- 0.0 - 3.5
- 3.5 - 7.0
- 7.0 - 10.5
- 10.5 - 14.0
- 14.0 - 17.6

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N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 11 - Flow Velocities PP Site.mxd 3/20/2009

FIGURE 11

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flow Velocities
Post-Project

Ivanpah 3

Ivanpah 2

Ivanpah 1

N

0 1,250 2,500
Feet

LEGEND

- Approx. Project Limits
- 2D Model Limts
- HEC-1 Watershed Boundary
- Modeled Ephemeral Channels

Flow Velocity (fps)

- 0.0 - 3.5
- 3.5 - 7.0
- 7.0 - 10.5
- 10.5 - 14.0
- 14.0 - 17.6

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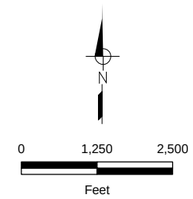
N:\Clients\351 BrightSource Energy\00-08-01 Ivanpah Powerplant\GIS\Figures\TM 6 Figure 12 - Flow Velocity Change Site.mxd 3/23/2009

FIGURE 12

BrightSource Energy
Ivanpah Solar Electric Generating System

100-Year Flow Velocity Changes Post-Project



Ivanpah 3

Ivanpah 2

Ivanpah 1

LEGEND

- Approx. Project Limits
- 2D Model Limts
- Modeled Ephemeral Channels

Velocity Change (fps)

- -3.70 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50

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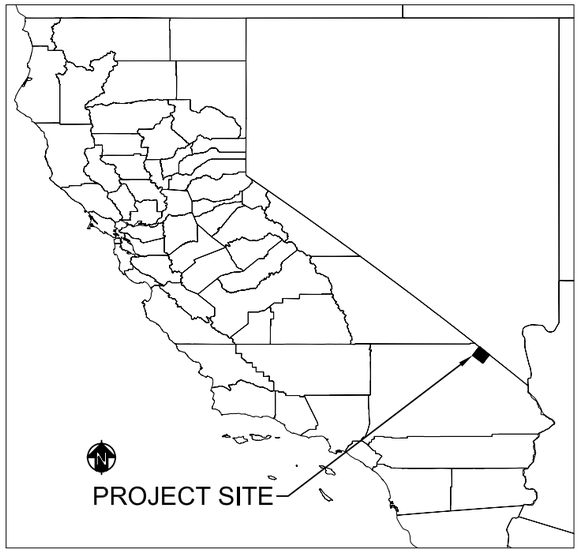
Consulting Engineers

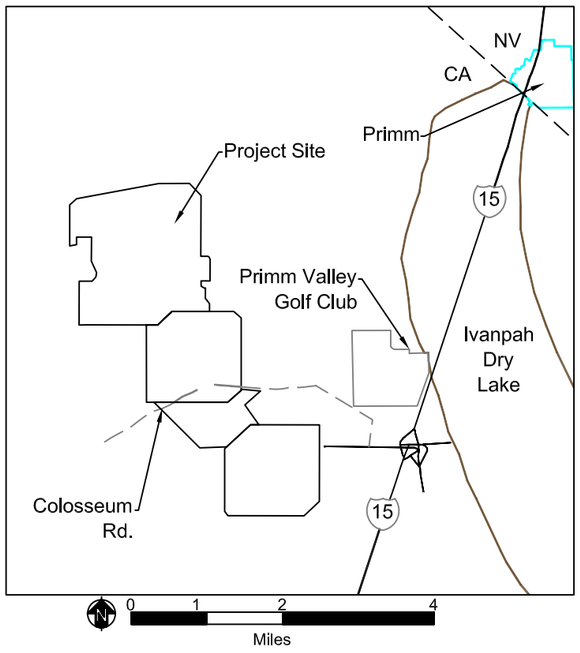
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

BRIGHTSOURCE ENERGY



Vicinity Map



Project Site Map

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	Construction Logistics Area Layout Plan	N/A	3
Utilities	Construction Logistics Area Utility Plan	N/A	4
Roadways	Ivanpah 1 Roadway Plan	5A	5
Utilities	Ivanpah 1 Utility Plan	N/A	6
	Ivanpah 1 Power Block Utility Plan	6A	7
General	Existing Watershed and Washes	3	8
	Stormwater Management Plan	4	9
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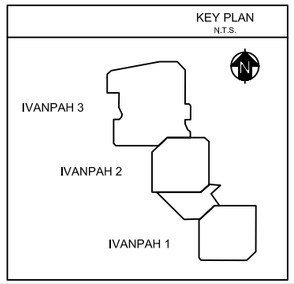
Legend

- Riprap
- 2/24 — Typical Detail Callout
- Embankment Slope
- Native Soil
- W — Water/Fire Line
- OE — Overhead Electrical and Fiber Optic Line
- OE — Existing Overhead Electrical Line
- GAS — Gas Line
- G — Existing Gas Line
- X — Fence Line
- 3000 — Contour
- Paved Road ℄
- Dirt Road ℄
- Dirt Path ℄
- Gravel Road ℄
- Project Boundary
- Stabilized Channel Crossing

BrightSourceEnergy

IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

Contact List:

BrightSource Energy	Tom Reagan	510-250-8160
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Tetra Tech EM, Inc.	Kevin Bricknell	510-302-6306
West Yost Associates	Tim Durbin	530-756-5905

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

TITLE SHEET
COVER SHEET AND
FIGURE INDEX

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	

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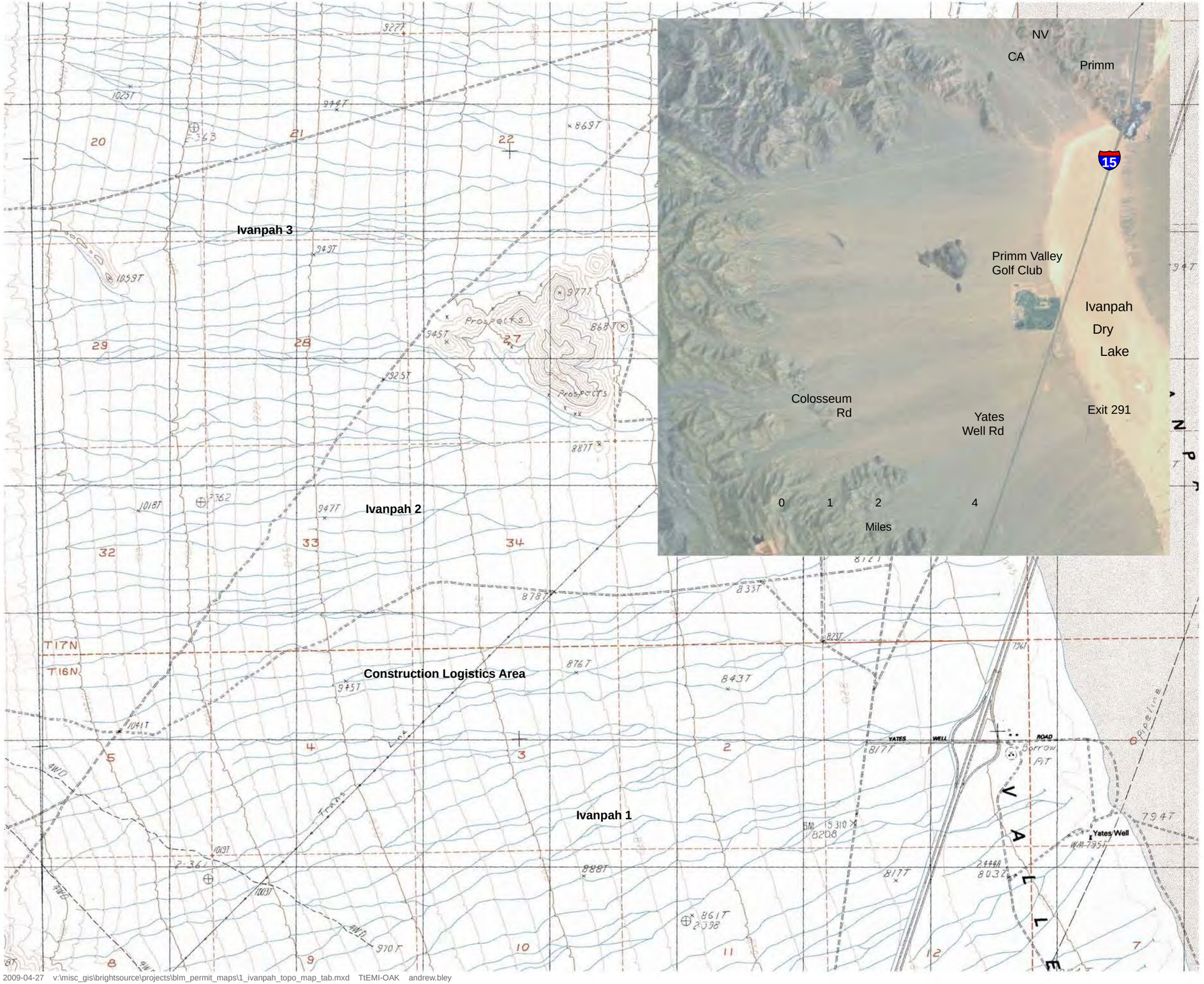

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BrightSourceEnergy

IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

PROJECT AREA

TETRA TECH

Project Boundary

Project Boundary

Note: Contour intervals are presented in feet within the project area and meters within the USGS Topoquad.

Project Bounds, Worley Parsons, Feb. 2009
Contour lines and LiDAR data, Airborne 1, Feb. 20, 2008
USGS Topoquad, 2004
Aerial Imagery, ESRI

0 2,500 5,000

Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

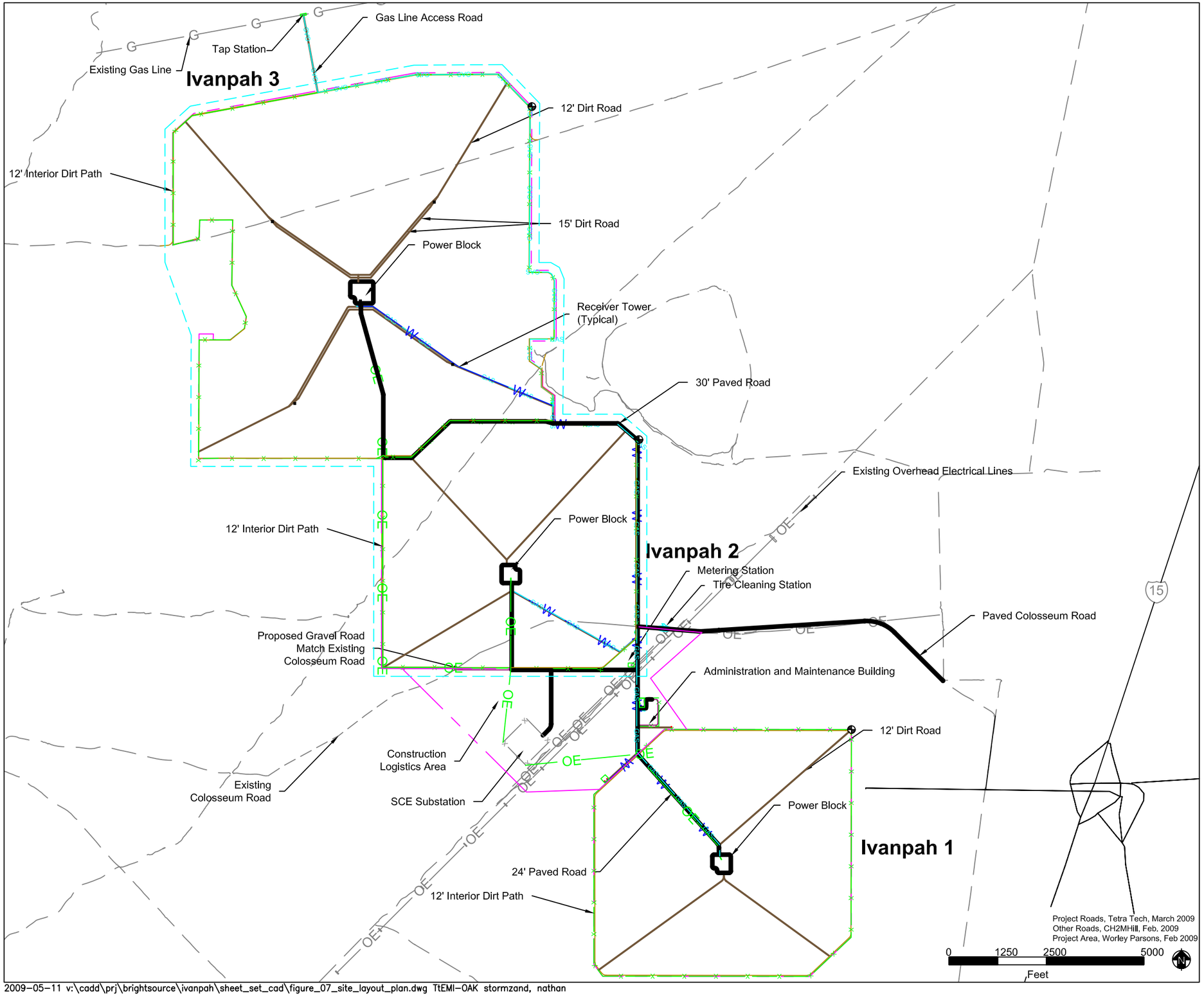
FIGURE 1

VICINITY MAP

NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

Date:
May 11, 2009

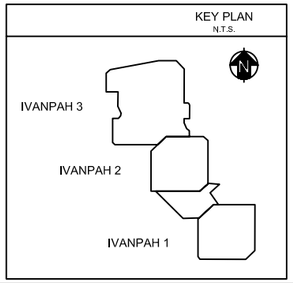


2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_07_site_layout_plan.dwg TtEMI-OAK stormzand, nathan

BrightSourceEnergy

IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

- Dirt Road
- Paved Road
- Gravel Road
- Dirt Path
- Future Work Phase
- Project Boundary
- Existing Four Wheel Drive Trail
- W — Water/Fire Line
- OE — Overhead Electrical and Fiber Optic Line
- OE — Existing Overhead Electrical Line
- GAS — Gas Line
- Temporary Horizontal Benchmark

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 2
SITE LAYOUT PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

Proposed Road
Match Existing Colosseum Road

Paved Colosseum Road Phase 1

30' Paved Road

Construction
Logistics Area

Gas Metering Set
100' x 150'

Transition from 24' Paved
Road to 24' Gravel Road

120'
Administration and
Maintenance Building

Paved Parking Administration Area

24' Gravel Road

Centerline Administration
Building 585LF Paved
1295LF Gravel

Access Gate

725'

Fenceline

Approximate Building
Area 115,565 sqft

500'

150'

SCE Substation
See Common Area Grading Plan
Figure 13

24' Paved Road

Existing Transmission
Lines

24' Double Wide
Swing Gate

850'

485'

830'

24' Paved Road

Groundwater Monitoring
Well 4' Above 100-Year
Flood Level

24' Double Wide Swing Gate

Production Water Wells (2)

2009-05-12 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_08_common_area_layout_plan.dwg TtEMI-OAK stormzand, nathan

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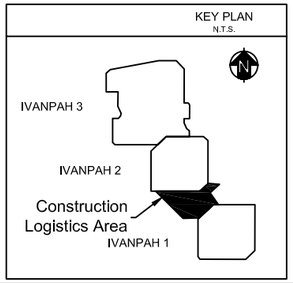
IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

KEY PLAN
N.T.S.



TETRA TECH

Fenceline
Gravel Road
Dirt Road
Paved Road
Project Boundary
OE Existing Overhead Electrical Line

N90°00'00"E 20.0' Bearing and Distance for Boundary

3970 Total LF of Paved Road Not including Colosseum Road
1460 Total LF of Gravel Road
3985 Total LF of Dirt Road
3815 Total LF of Colosseum Road Upgrade This Sheet
All Dimensions Shown are Approximate

0 200 400 800
Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	AB	BS
A	03/23/09	Preliminary Draft Issue	DM	AB	BS

FIGURE 3
CONSTRUCTION LOGISTICS AREA LAYOUT PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

Stormwater Diversion Channel
See Figure 13

SCE Substation
See Figure 13

Gas Metering Set
100' x 150'

Proposed Water Line

Proposed Gas Line

Existing Transmission Lines

Administration and Maintenance Building
See Figure 13

Groundwater Monitoring Well 4' Above 100-Yr Flood Level

Overhead Electrical Line

Production Water Wells (2)

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_18_common_area_utility_plan.dwg TtEMI-OAK stormzand, nathan

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IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

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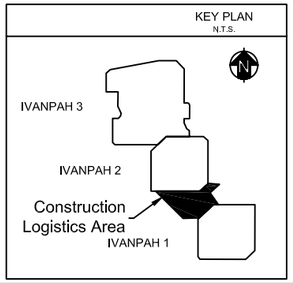
KEY PLAN
N.T.S.



TETRA TECH

- W — Water/Fire Line
- OE — Overhead Electrical and Fiber Optic Line
- OE — Existing Overhead Electrical Line
- GAS — Gas LIne
- X — Fenceline
- Project Boundary
- Project Road
- Fire Hydrant
- Project Site Area

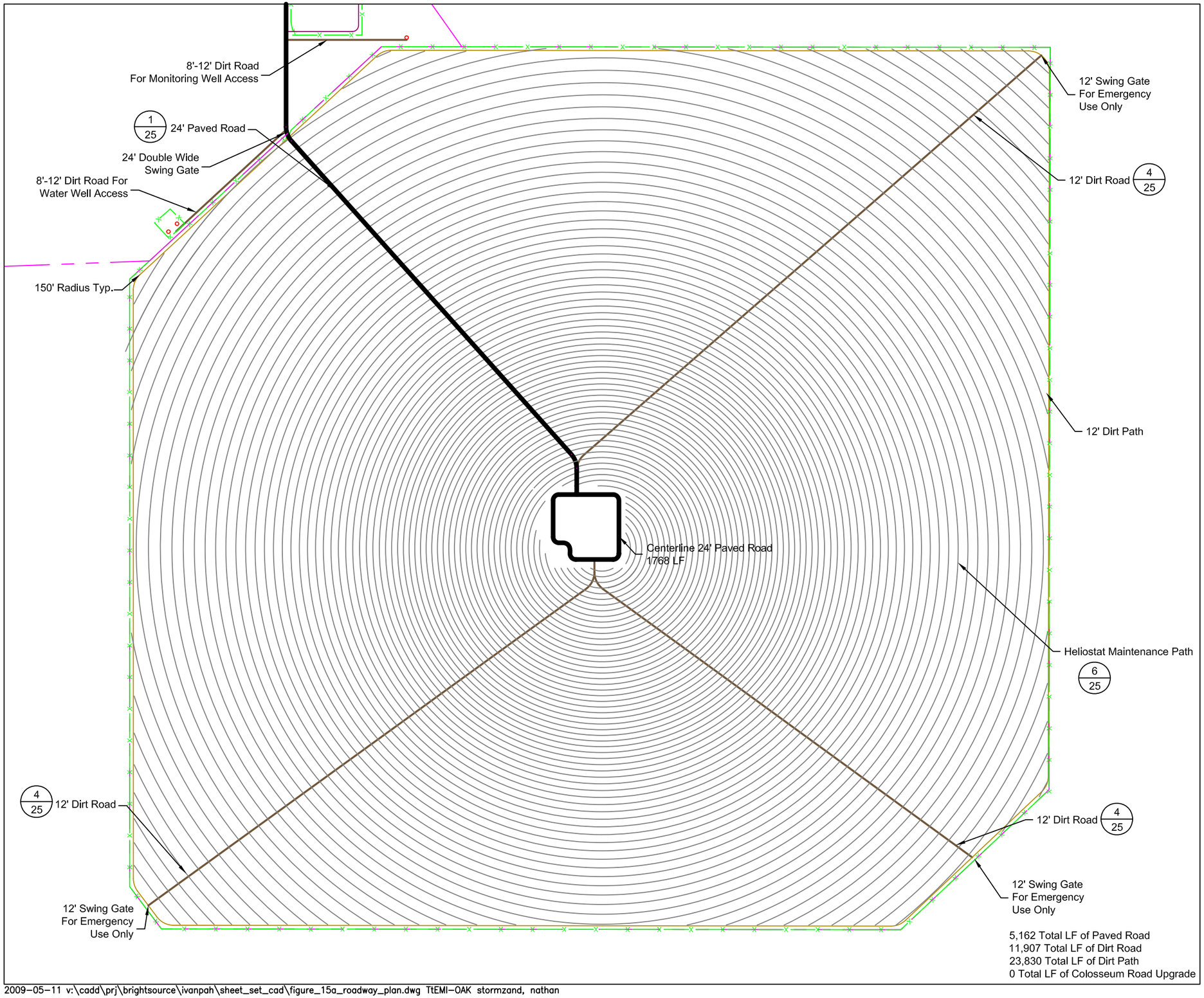
0 200 400 800
Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	AB	BS
A	03/23/09	Preliminary Draft Issue	DM	AB	BS

FIGURE 4
CONSTRUCTION LOGISTICS AREA UTILITY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009



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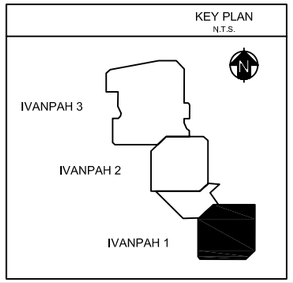


TETRA TECH

- Dirt Road
- Dirt Path
- Paved Road
- Gravel Road
- Heliostat Maintenance Path
- Project Boundary
- Fenceline

N90°00'00"E 20.0' Bearing and Distance for Roadway

All Dimensions Shown are Approximate

0 350 700 1400 N
Feet

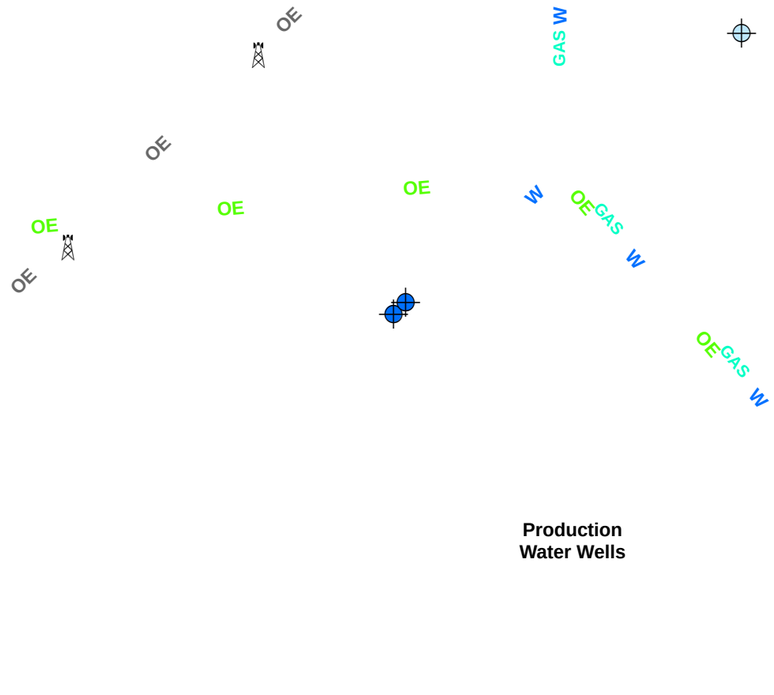
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 5
IVANPAH 1 ROADWAY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_15a_roadway_plan.dwg TtEMI-OAK stormzand, nathan



Groundwater Monitoring Well

Ivanpah 1

Production Water Wells

0 750 1,500

Feet

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IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

15

TETRA TECH

W	Water/Fire Line
GAS	Gas Line
OE	Overhead Electric
OE	Existing Overhead Electrical Line
	Groundwater Monitoring Well
	Production Water Well
	Existing Tower
	Proposed Graded Feature
	Project Boundary

Utility Data, CH2MHill, March 2009
Project Area, Worley Parsons, Feb. 2009
Proposed Grading Areas, BrightSource, April 2009

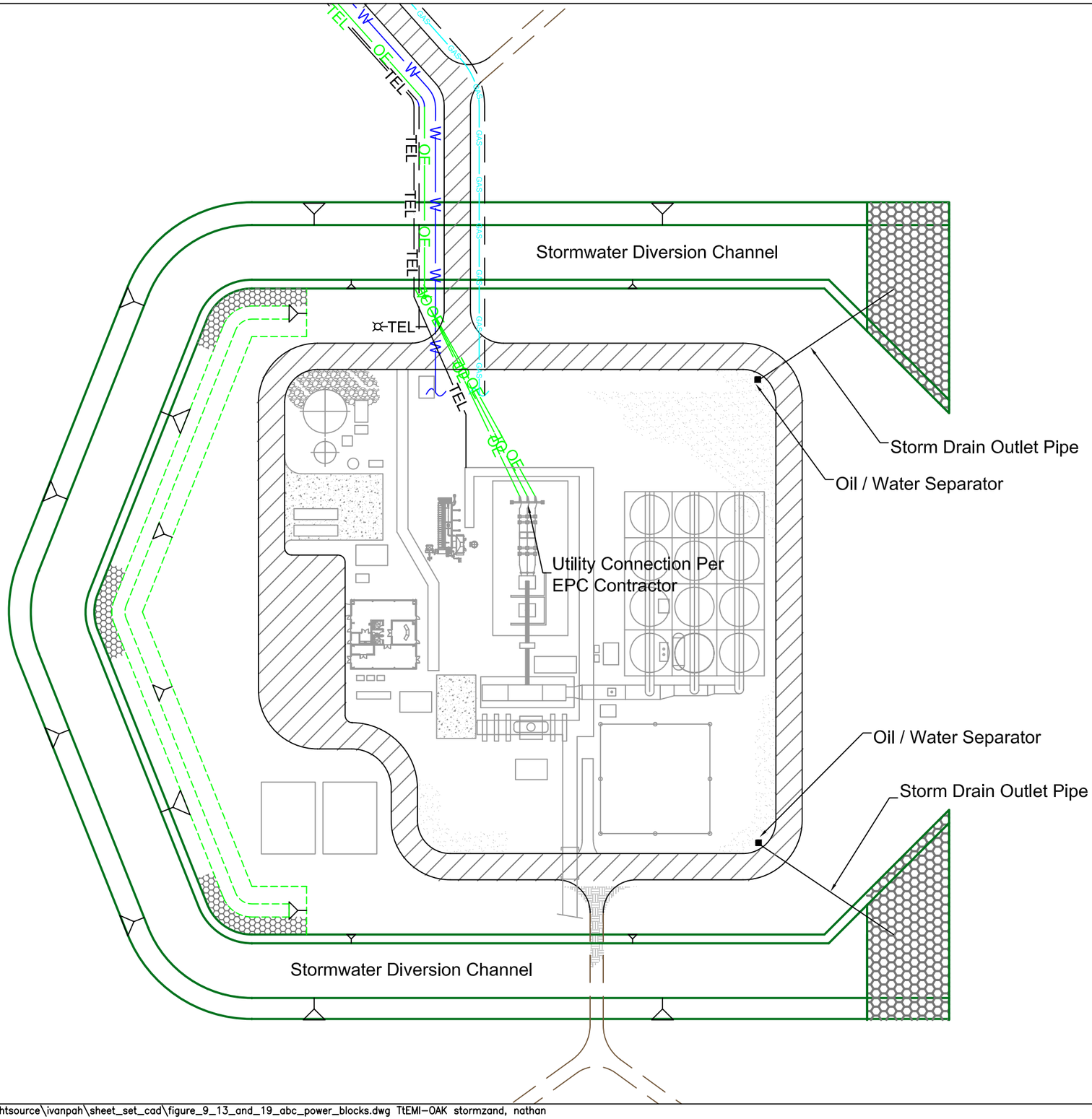
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

FIGURE 6
IVANPAH 1 UTILITY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT # 106-3850

Date: May 11, 2009



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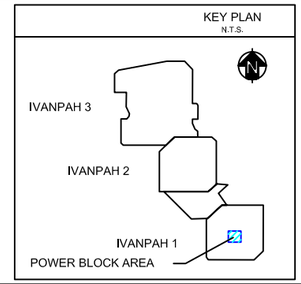
SAN BERNARDINO COUNTY, CA



TETRA TECH

- Stormwater Protection Berm
- Stormwater Diversion Channel
- Stormwater Riprap
- Paved Roads
- Gravel/Dirt Roads
- GAS — Natural Gas Line
- OE — Overhead Electric Line
- W — Water Line
- TEL — Telephone Line

0 50 100 200
Feet

Stormwater Controls, Tetra Tech, March 2009
Power Block Design, Worley Parsons, Feb 2009

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC

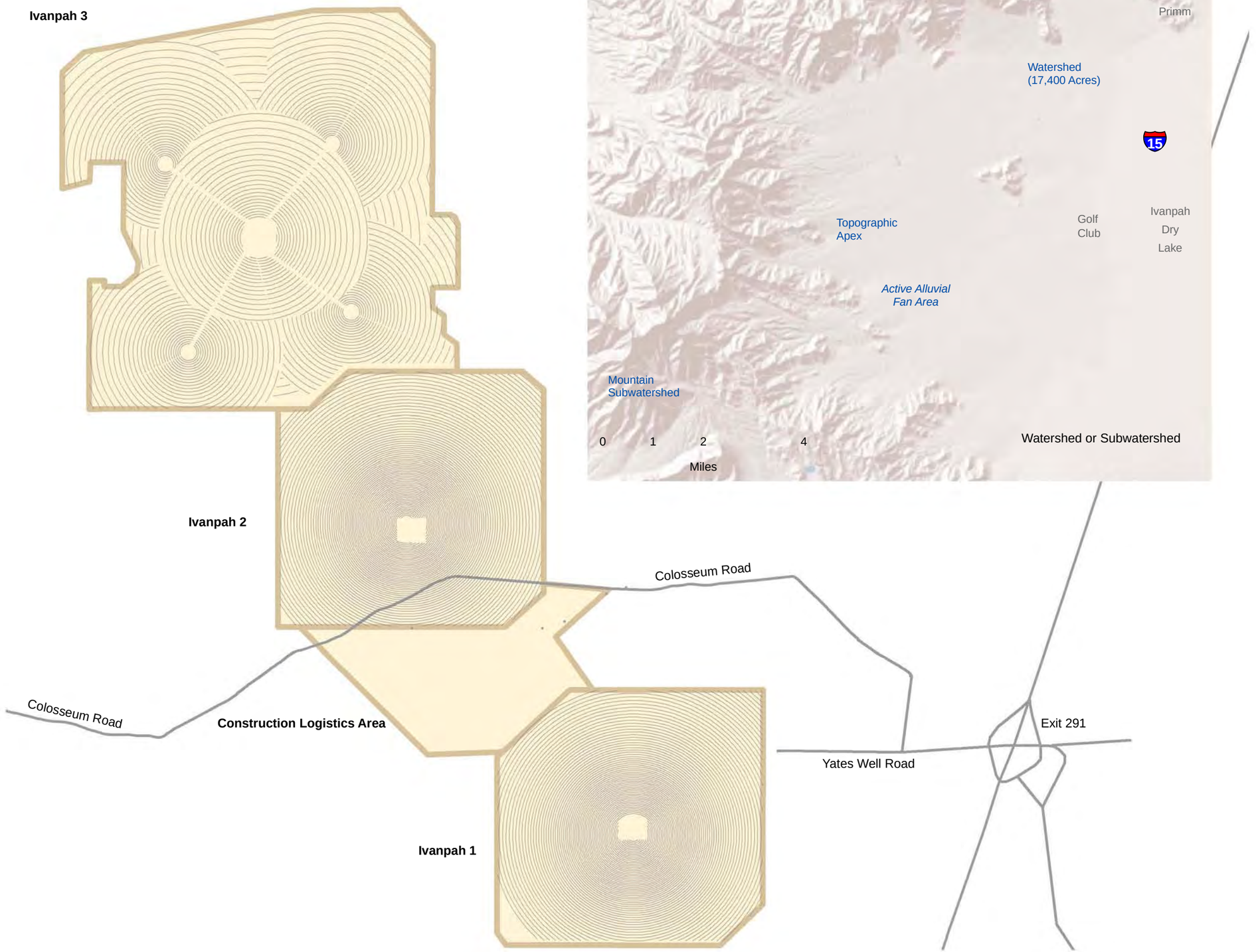
FIGURE 7
IVANPAH 1 POWER BLOCK UTILITY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_9_13_and_19_abc_power_blocks.dwg TtEMI-OAK stormzand, nathan

Natural Gas Line
Maintenance Access Road



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IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

TETRA TECH

Category 1 Ephemeral Wash (36-85' Width)

Category 2 Ephemeral Wash (21-35' Width)

Category 3 Ephemeral Wash (11-20' Width)

Proposed Paved Road

Proposed Dirt Road

Proposed Gravel Road

Proposed Dirt Path

Proposed Unpaved Maintenance Path

Existing Road

Project Boundary

Note: Smaller washes are known but only these three categories are shown since they may be engineered at road crossings. Please see FIGURE 22 for descriptions of wash/road intersections.

Washes and watershed, CH2MHill, Feb. 2009
Contour lines, Airborne 1, Feb 20, 2008
Roads and project area, Worley Parsons, Feb 2009

0 2,500 5,000

Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

FIGURE 8

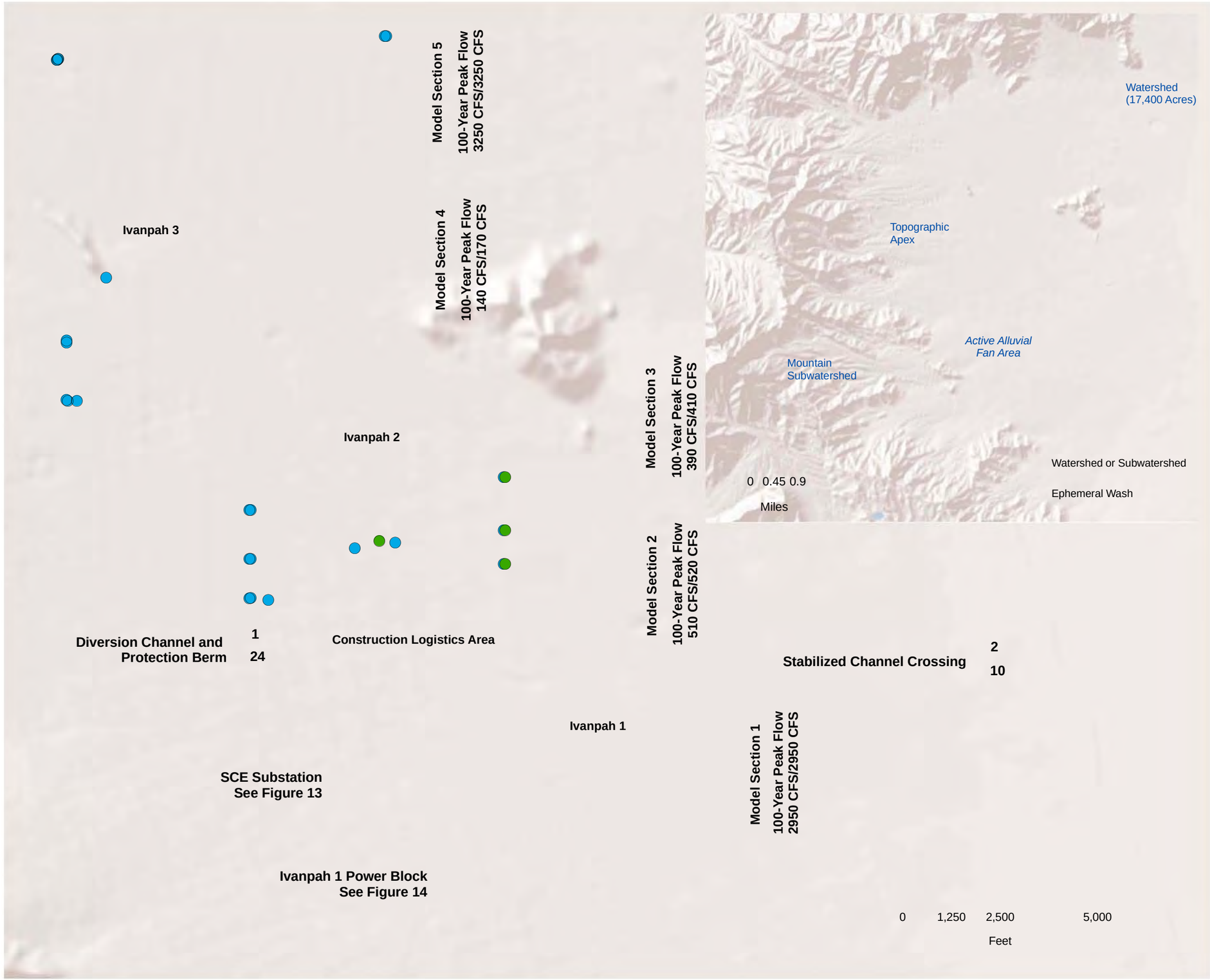
EXISTING WATERSHED AND WASHES

NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

Date:
May 11, 2009

2009-05-12 v:\misc_gis\brightsource\projects\blm_permit_maps\existing_watershed_plan_tab_map.mxd TtEMI-OAK nathan.stormzand



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IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

TETRA TECH

- Stabilized Channel Crossing
- Ephemeral Wash Crossing
- Stormwater Diversion Channel
- Stormwater Protection Berm
- Proposed Paved Road
- Proposed Dirt Road
- Proposed Gravel Road
- Proposed Dirt Path
- Ephemeral Washes (Categories 1 - 3)
- 100-Foot Contour
- Project Boundary
- **500 CFS/ 500 CFS** Pre/Post Development Flows Per WYA

Notes:
Channel corridors will be maintained with BMP controls as needed.

Washes and watershed, CH2MHill, Feb. 2009

Flow Rates provided by West Yost Associates (WYA), on April 8, 2009, based on Flo-2d modeling results. These values are identified as preliminary and may be changed as additional modeling is performed.

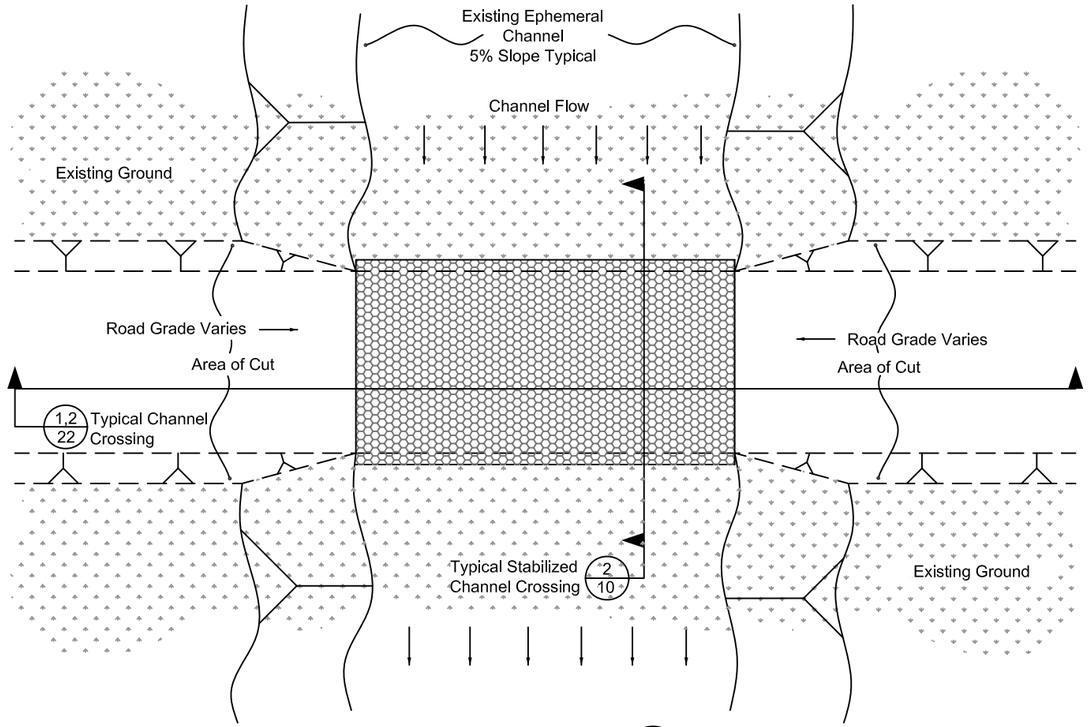
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	MC	BS
A	3/23/09	Preliminary Draft Issue	NS	MC	BS

FIGURE 9
STORMWATER MANAGEMENT PLAN

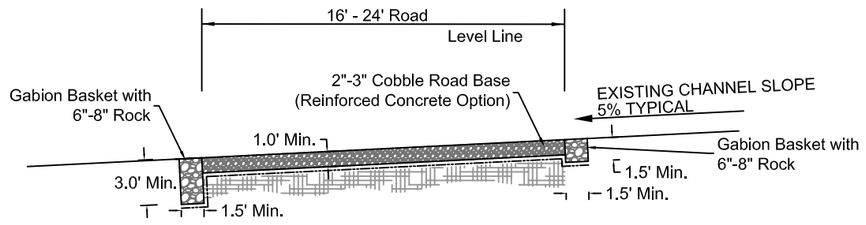
NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

DATE
May 11, 2009



TYPICAL STABILIZED CHANNEL CROSSING (1/10)
(NOT TO SCALE)



STABILIZED CHANNEL CROSSING TYPICAL DETAIL (2/10)
(NOT TO SCALE)

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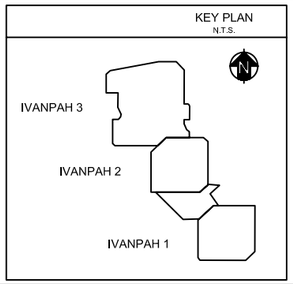
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



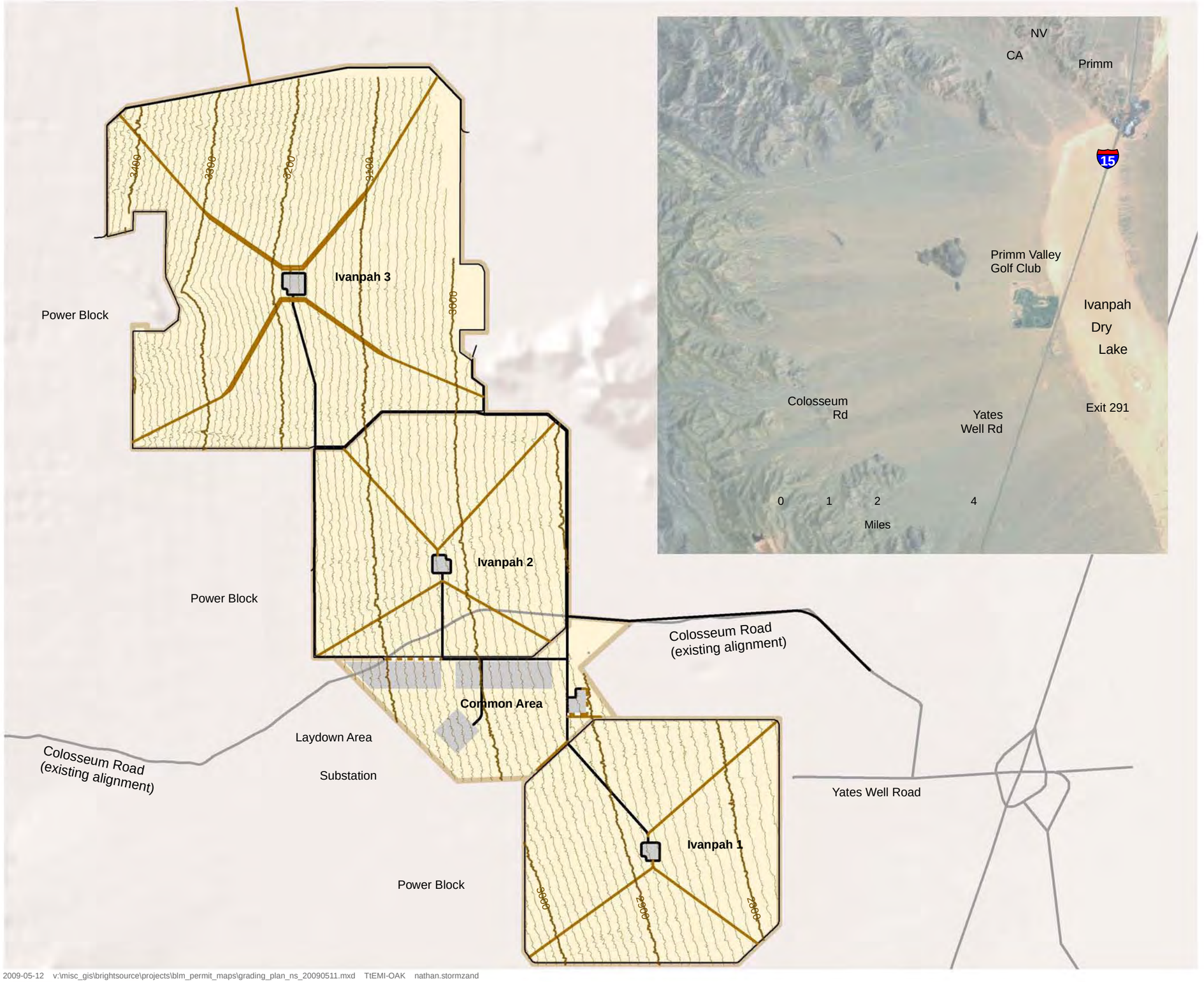
TETRA TECH

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC

FIGURE 10
TYPICAL STABILIZED CHANNEL CROSSING

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009



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BrightSourceEnergy

IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

TETRA TECH

Proposed Stabilized Channel Crossing

Light Grading and Rock Relocation

Potential Grading under Study

Proposed Other Graded Feature

Proposed Paved Road

Proposed Dirt Road

Proposed Gravel Road

Proposed Dirt Path

Existing Road (Varied Surface)

10-Foot Contour

100-Foot Contour

Project Boundary

Note: Proposed Stablized Crossings have been proposed in location where Category 1 and 2 ephemeral washes intersect paved roads.

Project Bounds, CH2M Hill, Feb. 2009
Contour lines and LiDAR data, Airborne 1, Feb. 20, 2008
Aerial Imagery, ESRI
Potential Grading and Stabilized Crossings,
BrightSource, March 20, 2009

0 2,500 5,000

Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

FIGURE 11

OVERALL GRADING PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT # 106-3850

DATE May 11, 2009

BrightSourceEnergy

IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

15

TETRA TECH

See Figure 14

2883' **2872'**

2885' **2874'**

Category 3 Ephemeral Wash (11-20' Width)
note: there are no Category 1 or 2 washes within Ivanpah 1

Proposed Paved Road

Proposed Dirt Road

Proposed Gravel Road

Proposed Dirt Path

Proposed Unpaved Maintenance Path

Project Boundary

10-Foot Contour

100-Foot Contour

Approximate Finished Grade Spot Elevation

Data Sources:
Contours and LiDAR Topography, Airborne 1, Feb. 20, 2008
Road and Path Allignments, Worley Parsons, Feb. 2009

0 750 1,500

Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

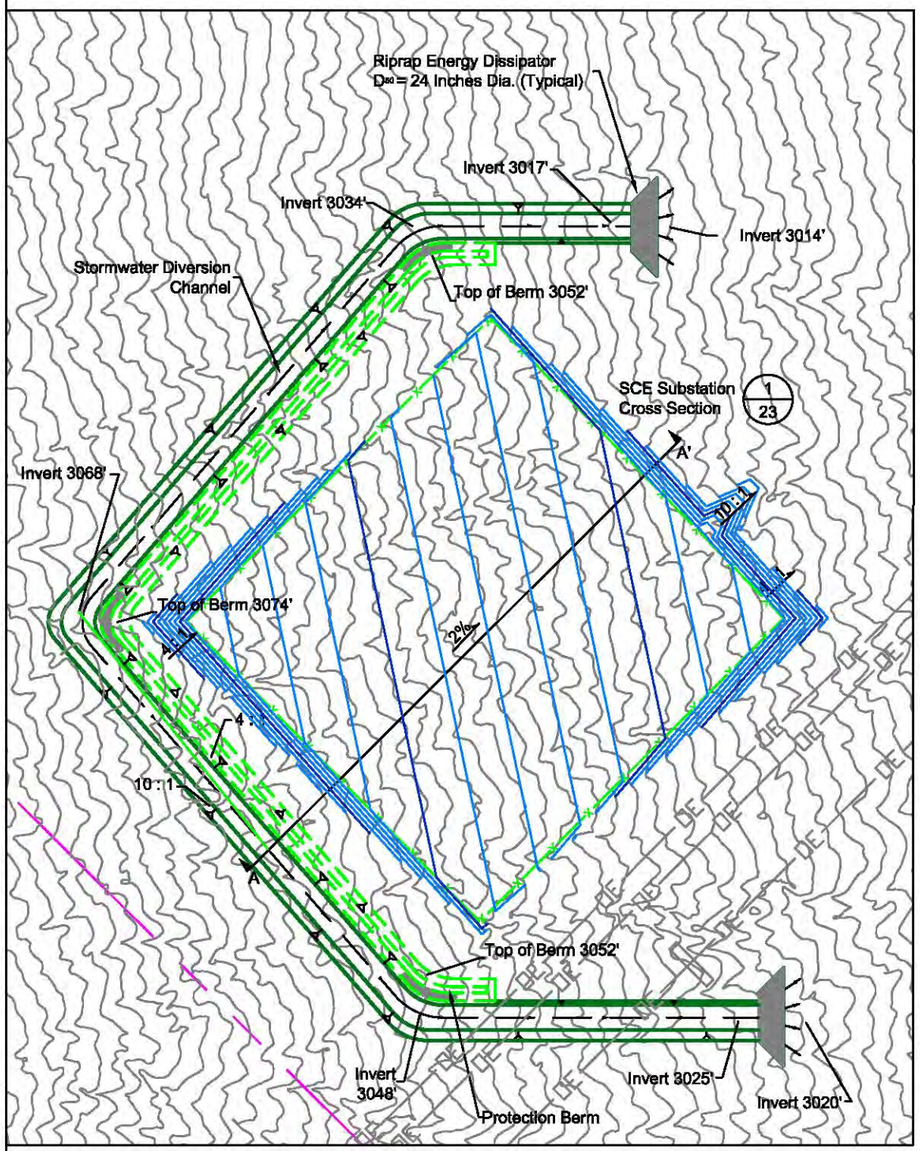
FIGURE 12

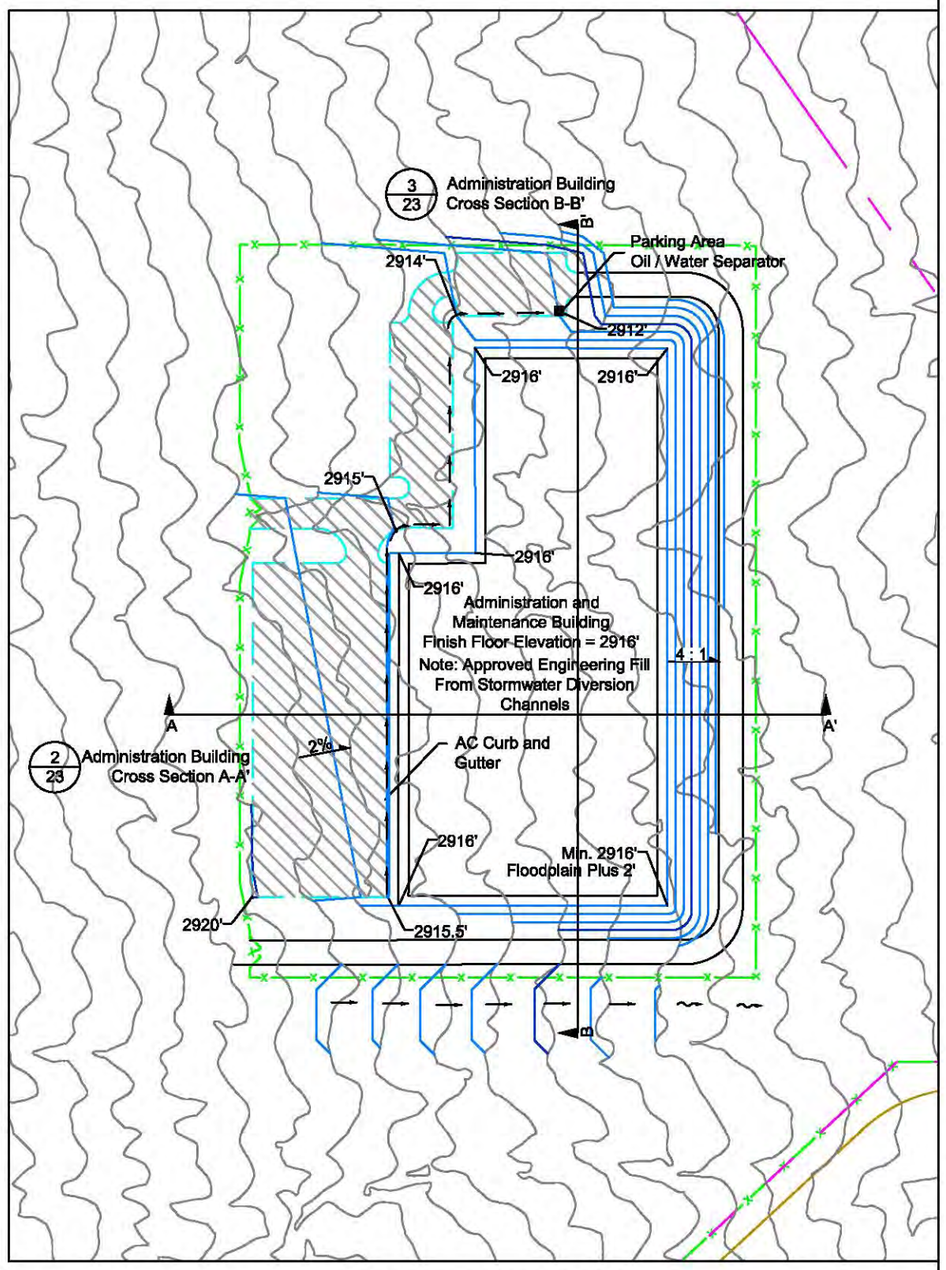
IVANPAH 1 GRADING PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

Date:
May 11, 2009





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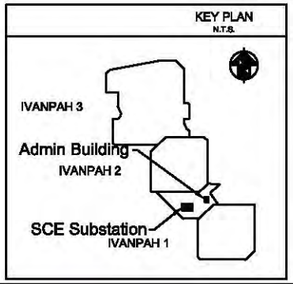
SAN BERNARDINO COUNTY, CA



TETRA TECH

- Stormwater Diversion Channel
- Stormwater Protection Berm
- Stormwater Control Flow Lines
- Stormwater Sheet Flow Lines
- Fenceline
- 3000 Existing Contours
- Proposed 2' Contours
- Proposed 10' Contours
- Pavement
- OE Existing Overhead Electric Lines
- Project Boundary

All Dimensions Shown are Approximate

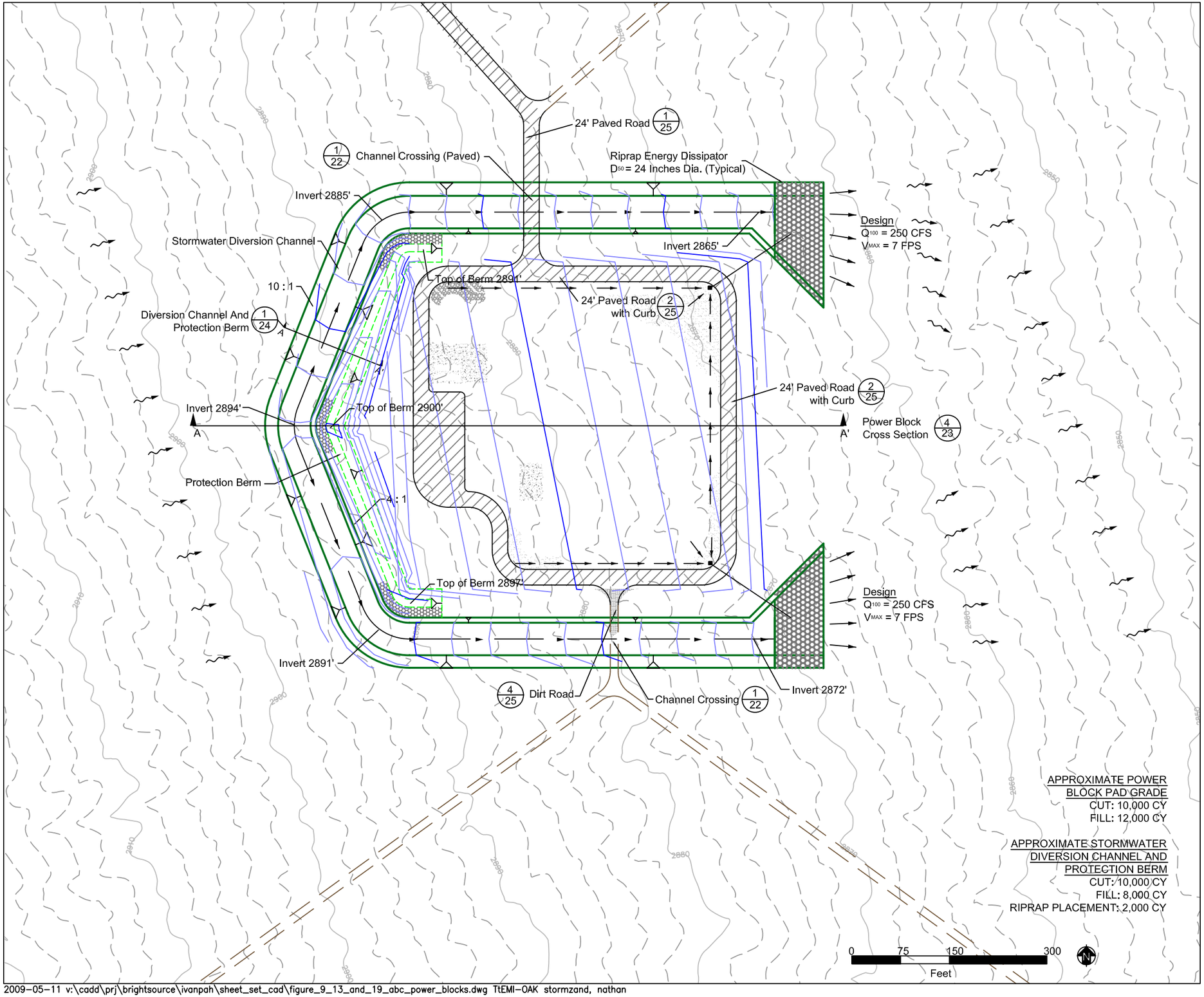
No.	Date	Description	Dsgn	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	MC	BS
A	03/23/09	Preliminary Draft Issue	DM	MC	BS

FIGURE 13
SUBSTATION AND ADMINISTRATION BUILDING GRADING PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_13_common_area_grading_plan.dwg TtEMI-OAK stormzand, nathan



2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_9_13_and_19_abc_power_blocks.dwg TtEMI-OAK stormzand, nathan

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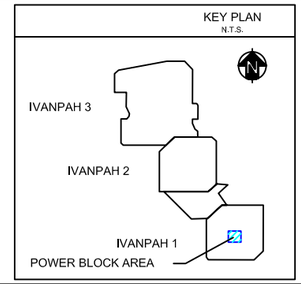
SAN BERNARDINO COUNTY, CA



TETRA TECH

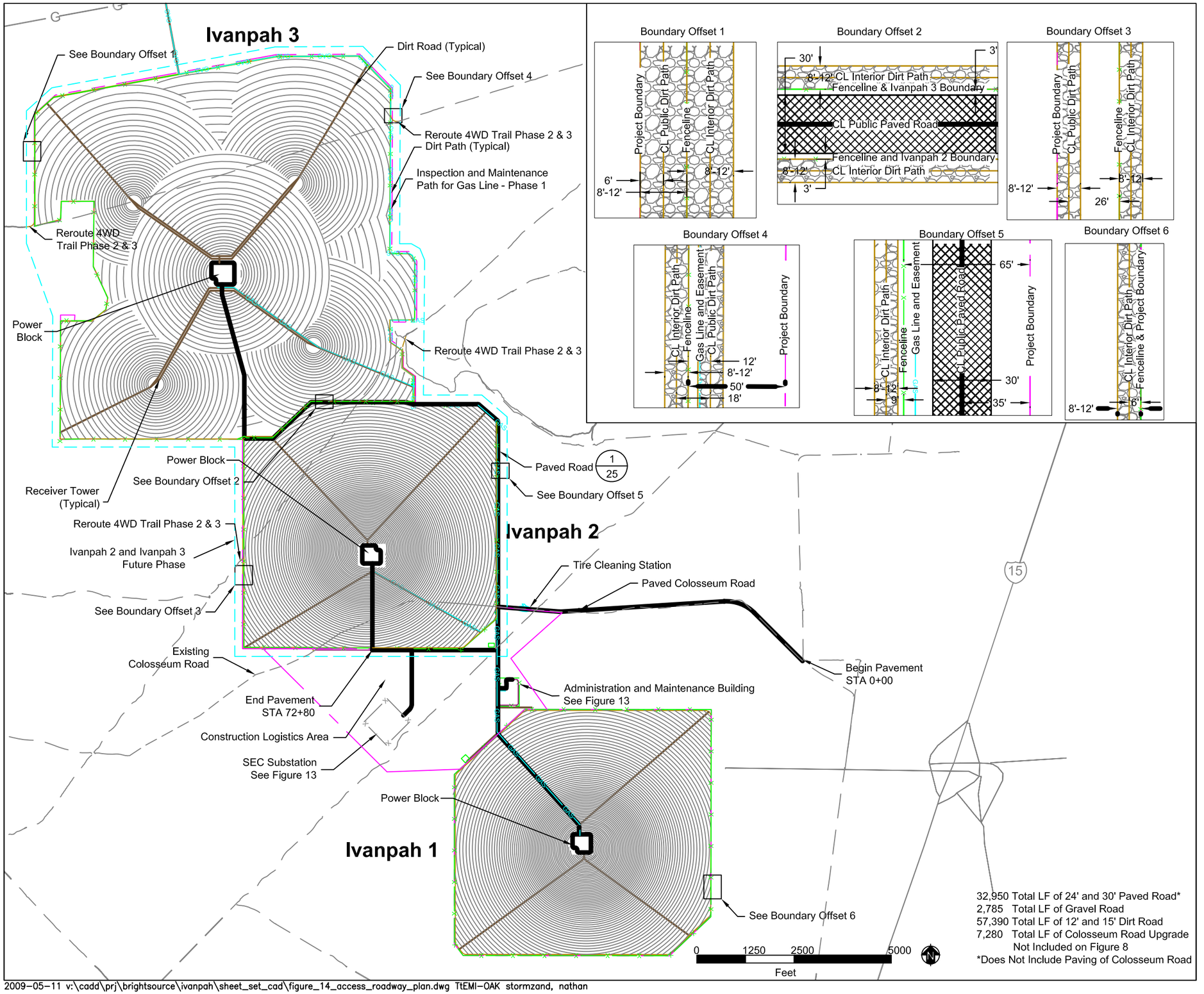
- Stormwater Protection Berm
- Stormwater Diversion Channel
- Stormwater Control Flow Lines
- Stormwater Sheet Flow Lines
- Stormwater Riprap
- Paved Roads
- Gravel/Dirt Roads
- 3000 Existing Contours
- Proposed 2' Contours
- Proposed 10' Contours

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC

FIGURE 14
IVANPAH 1 POWER BLOCK GRADING PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	



2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_14_access_roadway_plan.dwg TtEMI-OAK stormzand, nathan

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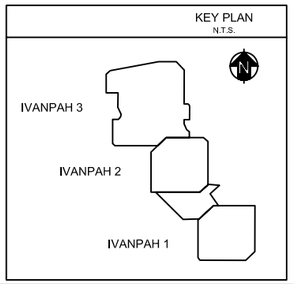
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

- Heliostat Maintenance Path
- Dirt Road
- Dirt Path
- Dirt Path (As Seen on Boundary Offsets)
- Paved Road
- Paved Road (As Seen on Boundary Offsets)
- Gravel Road
- Existing Colosseum Road
- Project Boundary
- Fenceline

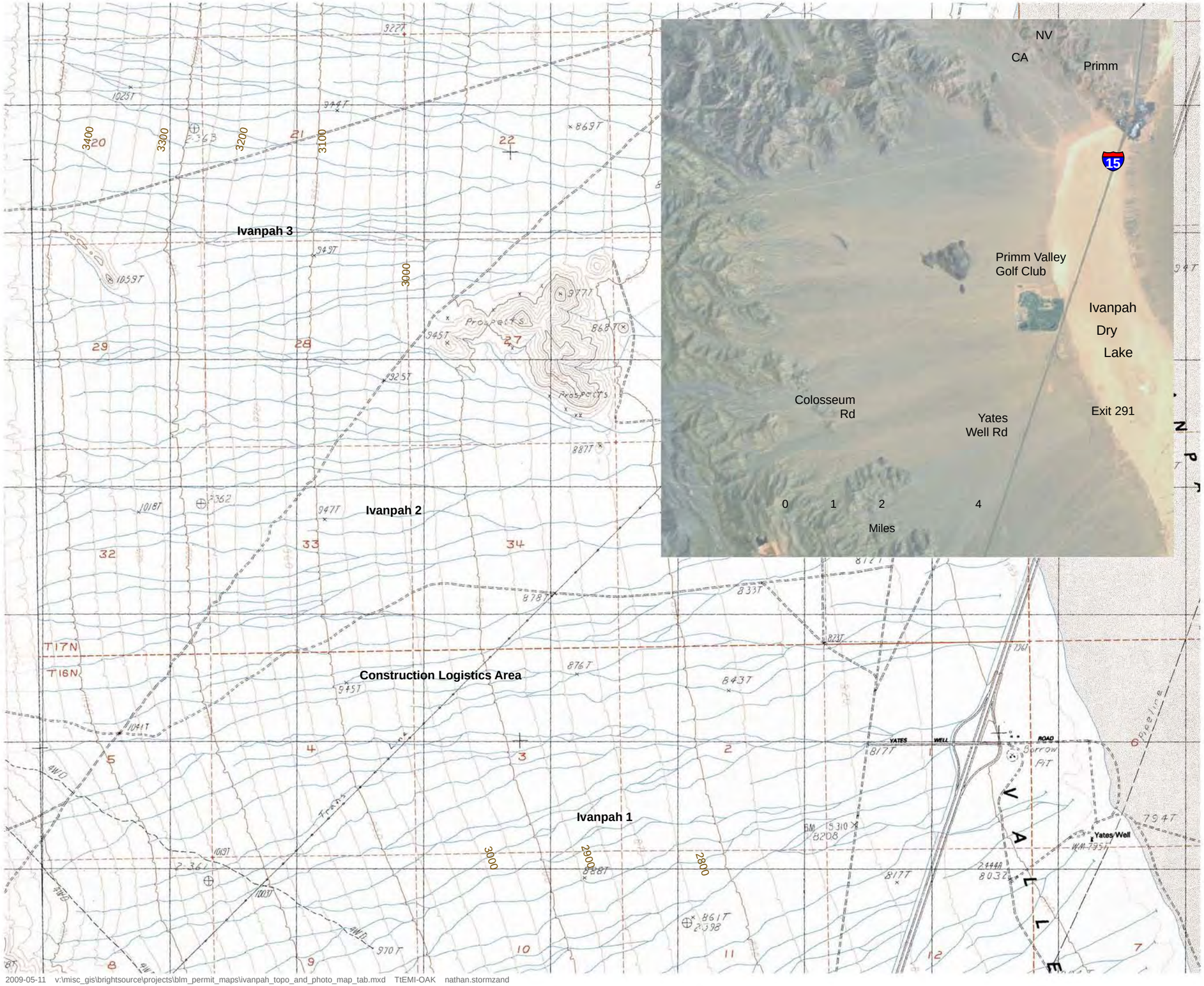
All Dimensions Shown are Approximate

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 15
ACCESS ROADWAY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	



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BrightSourceEnergy

IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA

PROJECT AREA

TETRA TECH

10-Foot Contour

100-Foot Contour

Project Boundary

Note: Contour intervals are presented in feet within the project area and meters within the USGS Topoquad.

Project Bounds, CH2M Hill, Feb. 2009
Contour lines and LiDAR data, Airborne 1, Feb. 20, 2008
USGS Topoquad, 2004
Aerial Imagery, ESRI

0 2,500 5,000

Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

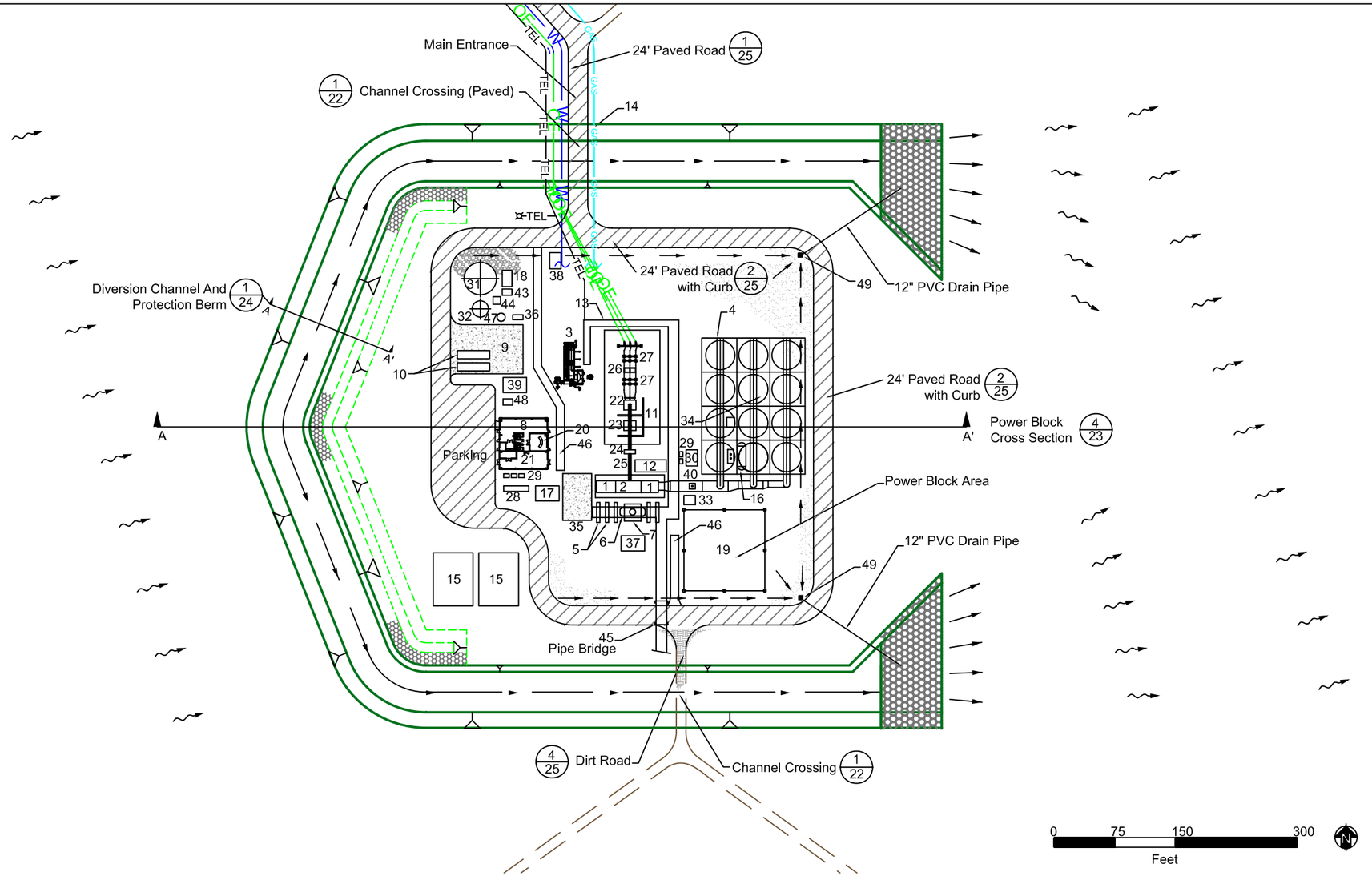
FIGURE 16

EXISTING TOPOGRAPHY AND AERIAL PHOTO

NOT ISSUED FOR CONSTRUCTION

PROJECT # 106-3850

Date: May 11, 2009



EQUIPMENT LEGEND:

1 STEAM TURBINE
2 GENERATOR
3 AUXILIARY BOILER
4 AIR COOLED CONDENSER
5 FEED WATER HEATERS
6 DEAERATOR
7 BOILER FEED PUMPS
8 PLANT SERVICES BUILDING
9 WATER TREATMENT EQUIPMENT AREA
10 WATER TREATMENT TRAILERS
11 FIREWALL
12 TURBINE LUBRICATION SYSTEM & CONTROL PACKAGE
13 PIPE RACK
14 UNDERGROUND GAS PIPELINE (CAUTION)
15 CONCRETE HOLDING BASINS
16 CONDENSATE TANK/PUMPS
17 EMERGENCY GENERATOR
18 FIRE PUMP MODULE (ELECTRIC, DIESEL & JOCKEY)
19 SOLAR SUPERHEATER/REHEATER RECEIVER & TOWER
20 LOCAL CONTROL ROOM
21 ELECTRICAL ROOM
22 GENERATOR STEP-UP TRANSFORMER
23 UNIT AUXILIARY TRANSFORMER
24 GENERATOR CIRCUIT BREAKER
25 ISOLATED PHASE BUS DUCT
26 115KV BREAKER
27 115KV DISCONNECT (MOD)
28 2.5MVA UPS
29 SUS TRANSFORMER
30 ACC PDC
31 RAW WATER/FIRE WATER TANK
32 DEMINILIZED WATER TANK
33 CYCLE CHEMICAL FEED / SAMPLE PANEL
34 VACUUM PUMP / SJAE
35 STG MAINTENANCE & EQUIPMENT LAY DOWN AREA
36 OIL/WATER SEPARATOR
37 FIN-FAN COOLER (AUX COOLING SYSTEM)
38 GAS METER & REGULATION STATION
39 OIL & CHEMICAL STORAGE
40 DUCT DRAIN SUMP & PUMP
41 UNDERGROUND WELL WATER SUPPLY LINE
42 115KV TRANSMISSION LINE
43 RAW WATER FORWARDING PUMPS
44 DEMINERIALIZED WATER FORWARDING PUMPS
45 PIPE BRIDGE
46 ACCESS ROAD AREA
47 WASTE WATER TANK
48 DOMESTIC WATER SYSTEM AND SEWER SYSTEM
49. OIL/WATER/SAND SEPARATOR

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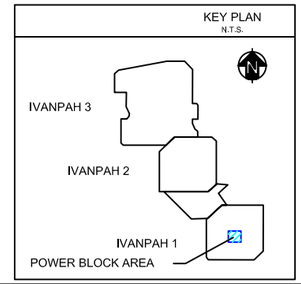
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

- Stormwater Protection Berm
- Stormwater Diversion Channel
- Stormwater Control Flow Lines
- Stormwater Sheet Flow Lines
- Stormwater Riprap
- Paved Roads
- Gravel/Dirt Roads
- Natural Gas Line
- Overhead Electric Line
- Water Line
- Telephone Line

Stormwater Controls, Tetra Tech, March 2009
Power Block Design, Worley Parsons, Feb 2009

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC

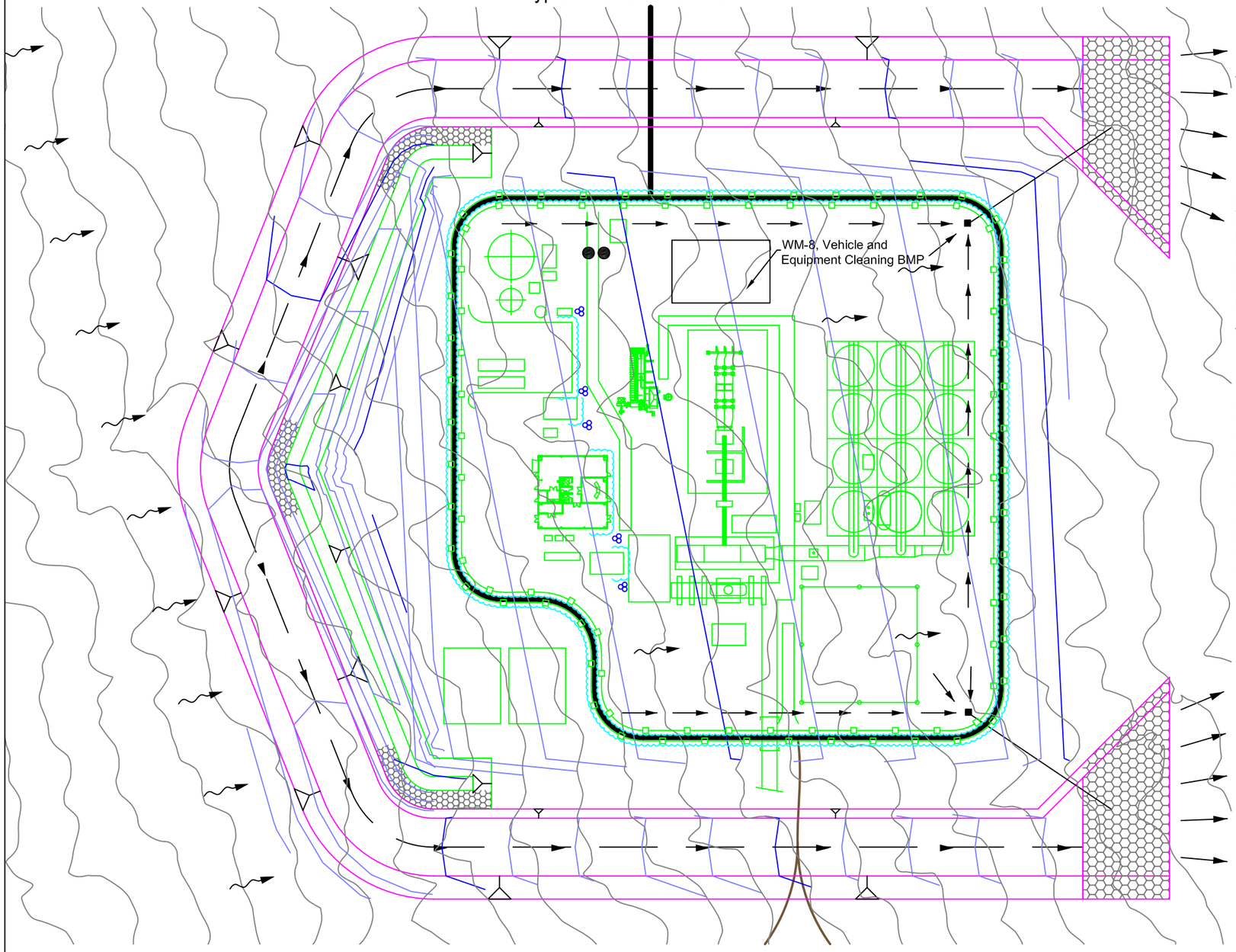
FIGURE 17
IVANPAH 1 POWER BLOCK LAYOUT PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT # 106-3850

May 11, 2009

Typical Power Block Plan



Power Block Typical BMPs

Erosion Control
- EC-1
- EC-3
- EC-6
- EC-7
- EC-9
- EC-10
- EC-11

Sediment Control
- SE-1
- SE-3
- SE-4
- SE-5
- SE-6
- SE-8

Non-Stormwater Management Control
- NS-1
- NS-3
- NS-12
- NS-13

Waste Management Control
- WM-1
- WM-2
- WM-3
- WM-4
- WM-5
- WM-6
- WM-8
- WM-9

Wind Erosion Control
- WE-1

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SAN BERNARDINO COUNTY, CA

Erosion Control
EC-1 Scheduling, EC-2 Preservation of Existing Vegetation, EC-3 Hydraulic Mulch, EC-5 Soil Binders, EC-6 Straw Mulch, EC-7 Geotextiles and Mats, EC-9 Earth Dikes and Drainage Swales, EC-10 Velocity Dissipation Devices, EC-11 Slope Drains, EC-12 Streambank Stabilization
Sediment Control
SE-1 Silt Fence, SE-2 Sediment Basin, SE-3 Sediment Trap, SE-4 Check Dams, SE-5 Fiber Rolls, SE-6 Gravel Bag Berm, SE-7 Street Sweeping and Vacuuming, SE-8 Sandbag Barrier
Tracking Control
TC-1 Stabilized Construction Entrance/Exit, TC-2 Stabilized Construction Roadway, TC-3 Entrance/Outlet Tire Wash
Wind Erosion
WE-1 Wind Erosion Control
Non-Stormwater Management Control
NS-1 Water Conservation Practices, NS-2 Dewatering Operations, NS-3 Paving and Grinding Operations, NS-8 Vehicle and Equipment Cleaning, NS-9 Vehicle and Equipment Fueling, NS-10 Vehicle and Equipment Maintenance, NS-12 Concrete Curing, NS-13 Concrete Finishing
Waste Management and Materials Pollution Control
WM-1 Material Delivery and Storage, WM-2 Material Use, WM-3 Stockpile Management, WM-4 Spill Prevention and Control, WM-5 Solid Waste Management, WM-6 Hazardous Waste Management, WM-7 Contaminated Soil Management, WM-8 Concrete Waste Management, WM-9 Sanitary/ Septic Waste Management

TETRA TECH

- Proposed Dirt Road
- Proposed Paved Road
- WM-9, Sanitary/Septic Waste Management BMP
- Stormwater Control Flow Lines
- Stormwater Sheet Flow Lines
- SE-1, Silt Fence BMP
- SE-4, Check Dam BMP
- SE-5, Fiber Roll BMP

Note - Stormwater Diversion Channel to be constructed first.

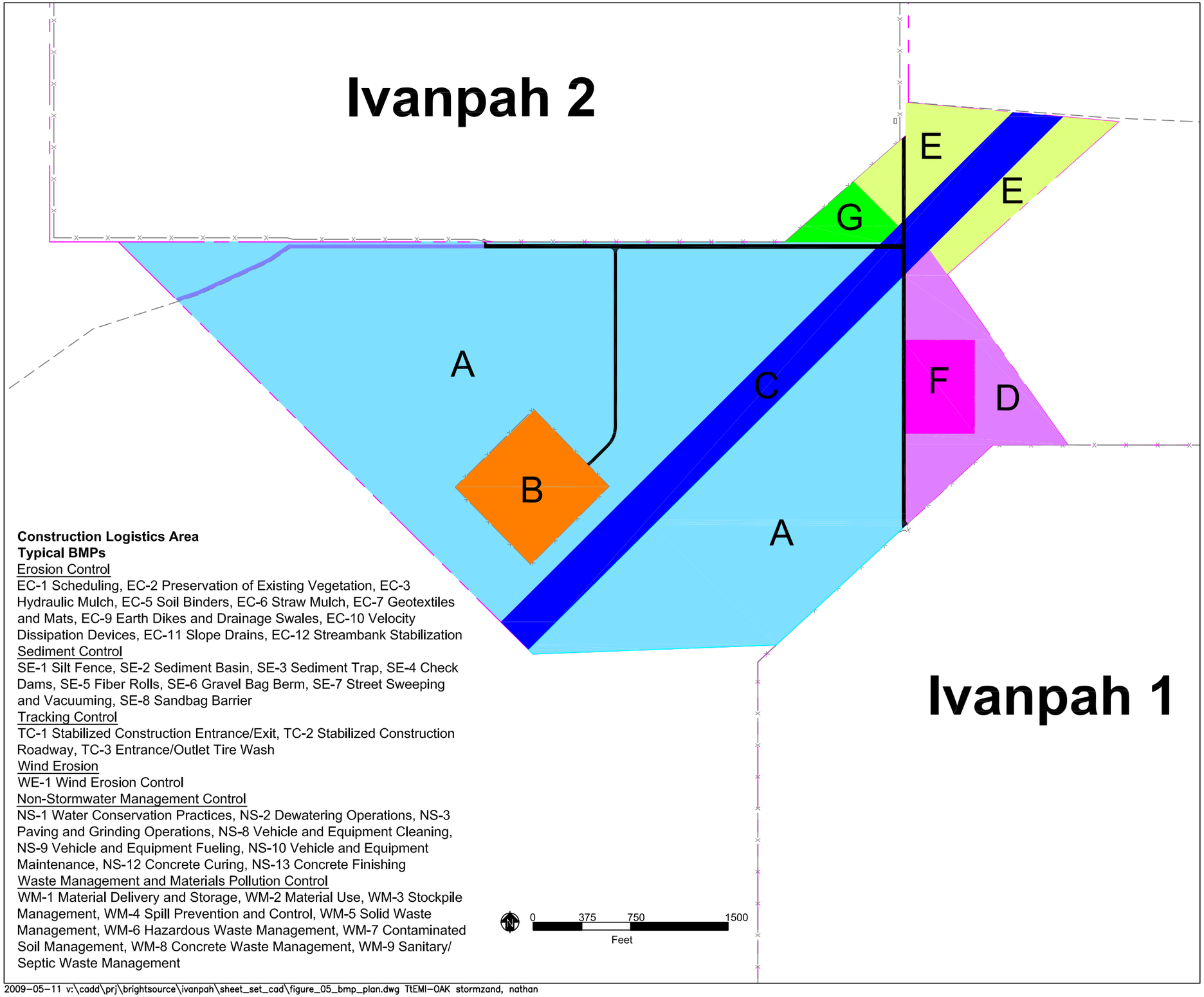
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 18
POWER BLOCK BMP PLAN FOR CONSTRUCTION

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_04_descp.dwg TtEMI-OAK stormzand, nathan



Construction Logistics Area
Typical BMPs

Erosion Control

EC-1 Scheduling, EC-2 Preservation of Existing Vegetation, EC-3 Hydraulic Mulch, EC-5 Soil Binders, EC-6 Straw Mulch, EC-7 Geotextiles and Mats, EC-9 Earth Dikes and Drainage Swales, EC-10 Velocity Dissipation Devices, EC-11 Slope Drains, EC-12 Streambank Stabilization

Sediment Control

SE-1 Silt Fence, SE-2 Sediment Basin, SE-3 Sediment Trap, SE-4 Check Dams, SE-5 Fiber Rolls, SE-6 Gravel Bag Berm, SE-7 Street Sweeping and Vacuuming, SE-8 Sandbag Barrier

Tracking Control

TC-1 Stabilized Construction Entrance/Exit, TC-2 Stabilized Construction Roadway, TC-3 Entrance/Outlet Tire Wash

Wind Erosion

WE-1 Wind Erosion Control

Non-Stormwater Management Control

NS-1 Water Conservation Practices, NS-2 Dewatering Operations, NS-3 Paving and Grinding Operations, NS-8 Vehicle and Equipment Cleaning, NS-9 Vehicle and Equipment Fueling, NS-10 Vehicle and Equipment Maintenance, NS-12 Concrete Curing, NS-13 Concrete Finishing

Waste Management and Materials Pollution Control

WM-1 Material Delivery and Storage, WM-2 Material Use, WM-3 Stockpile Management, WM-4 Spill Prevention and Control, WM-5 Solid Waste Management, WM-6 Hazardous Waste Management, WM-7 Contaminated Soil Management, WM-8 Concrete Waste Management, WM-9 Sanitary/ Septic Waste Management

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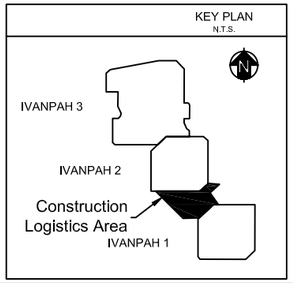
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

- Project Boundary
- Fence Line
- Paved Road (5.3 acres)
- Gravel Road (1.7 acres)
- A: Potential Equipment and Material Storage (260.0 acres)
- B: Substation Location (16.1 acres)
- C: Existing Transmission Line Corridor (38.9 acres)
- D: Contractor Trailers (20.1 acres)
- E: Equipment Laydown and Wash Area (21.5 acres)
- F: Administration/Maintenance Building and Parking (8.9 acres)
- G: Gas Metering Station Construction Laydown Area (5.0 acres)

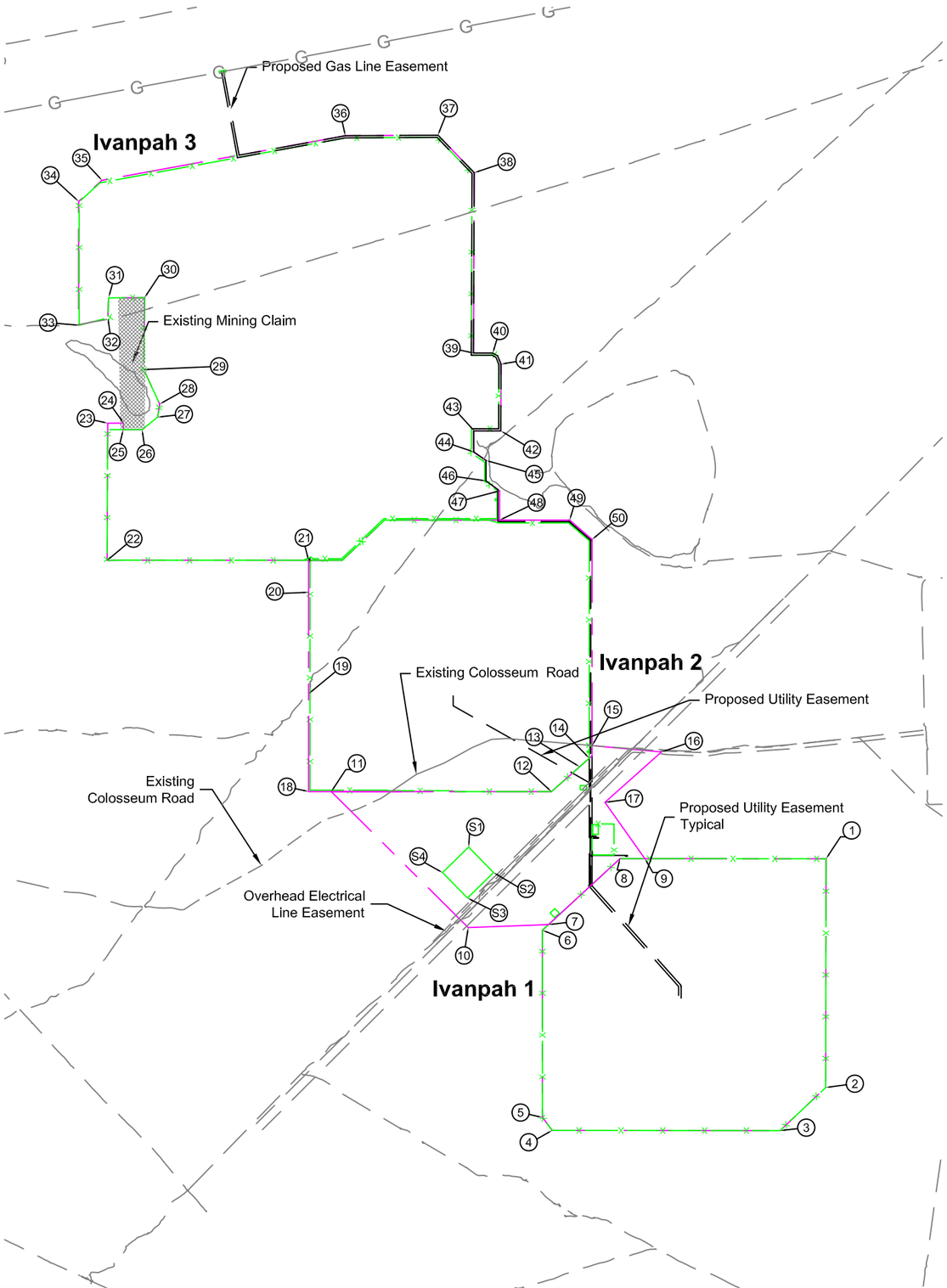
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 19
CONSTRUCTION LOGISTICS AREA BMP PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT # 106-3850	May 11, 2009

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_05_bmp_plan.dwg TtEMI-OAK stormzand, nathan



Project Boundary Control Points		
Point #	Easting	Northing
1	2104181.94	12908721.33
2	2104173.10	12903388.95
3	2103108.19	12902383.60
4	2097798.55	12902389.29
5	2097570.83	12902692.41
6	2097570.36	12907055.77
7	2097712.19	12907187.04
8	2099379.12	12908726.05
9	2099955.24	12908727.43
10	2095840.66	12907116.99
11	2092649.10	12910287.75
12	2097779.70	12910287.65
13	2098438.60	12910867.30
14	2098728.12	12911122.87
15	2098728.18	12911381.86
16	2100345.44	12911212.20
17	2099026.82	12910037.36
18	2092121.63	12910287.76
19	2092121.26	12912568.49
20	2092120.89	12914933.19
21	2092120.76	12915680.41
22	2087424.27	12915678.30
23	2087438.28	12918877.36
24	2087807.50	12918877.77
25	2087799.62	12918726.75
26	2088239.60	12918727.03
27	2088600.72	12919016.62
28	2088649.20	12919322.02
29	2088278.82	12920125.39
30	2088297.95	12921803.00
31	2087459.24	12921799.56
32	2087442.13	12921331.17
33	2086762.37	12921159.73
34	2086762.53	12924045.94
35	2087305.76	12924539.59
36	2092975.72	12925577.78
37	2095134.73	12925591.64
38	2095980.06	12924715.14
39	2095962.83	12920511.64
40	2096413.21	12920511.26
41	2096606.72	12920254.02
42	2096601.63	12918697.01
43	2095969.11	12918697.17
44	2095968.35	12918207.19
45	2096255.47	12918008.44
46	2096255.83	12917532.31
47	2096572.34	12917300.60
48	2096573.67	12916616.59
49	2098204.96	12916616.72
50	2098729.20	12916165.24
S1	2095850.34	12908994.49
S2	2096430.52	12908400.90
S3	2095822.66	12907806.76
S4	2095242.47	12908400.34

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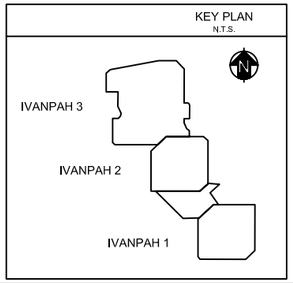
IVANPAH SOLAR ELECTRIC
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

Existing Colosseum Road

Project Boundary

Fenceline

4-Wheel Drive Trail

Existing Gas Line

Control Point Note - The points shown in the table provide a rough project boundary. The project site boundary will be updated once a lease agreement is finalized for the project

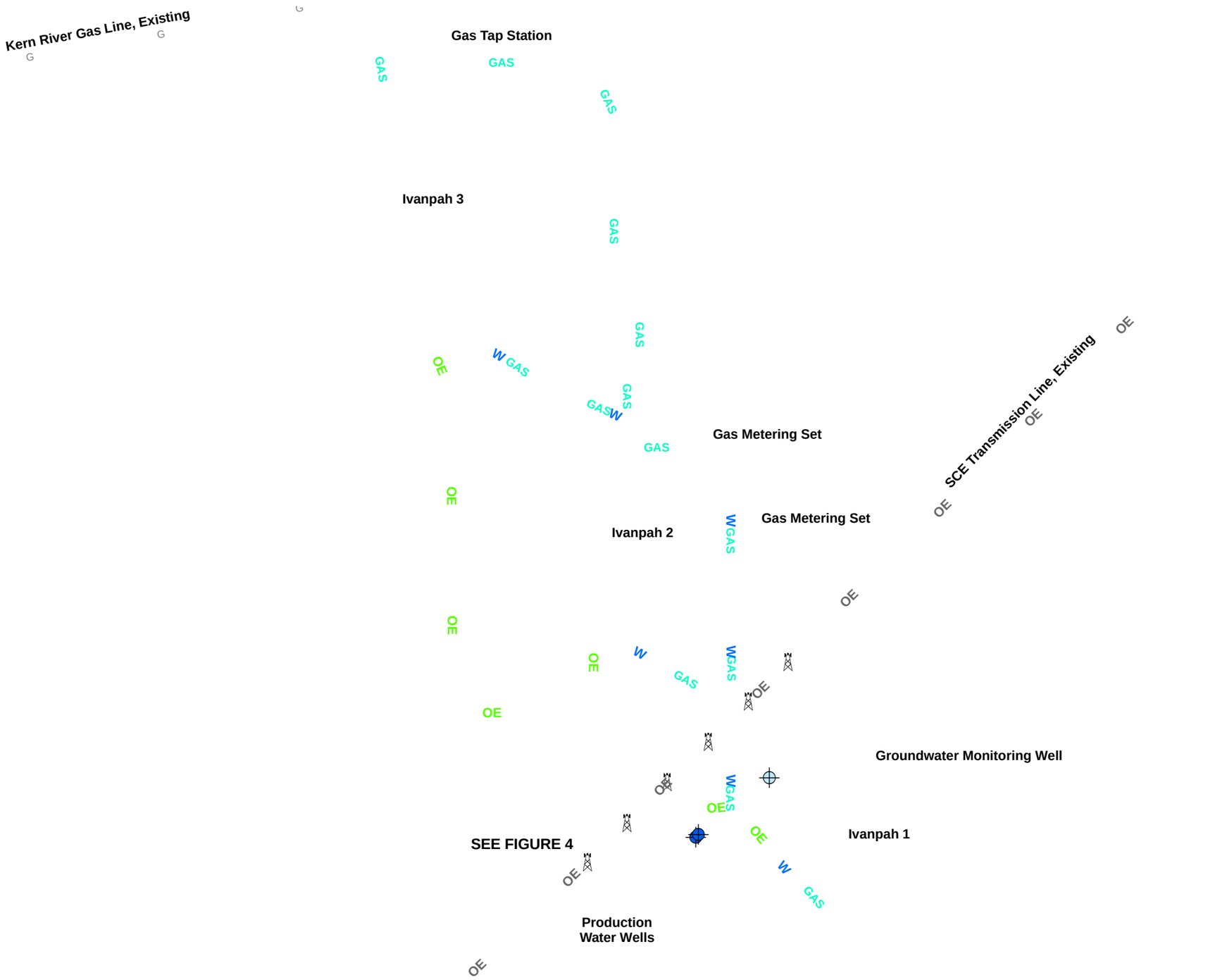
0 1500 3000 6000
Feet

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	DM	KB	BS
A	03/23/09	Preliminary Draft Issue	DM	KB	BS

FIGURE 20
BOUNDARY PLAN

NOT ISSUED FOR CONSTRUCTION

PROJECT #	May 11, 2009
106-3850	



0 2,500 5,000

Feet

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SAN BERNARDINO COUNTY, CA

TETRA TECH

W Water/Fire Line

GAS Gas Line

G Overhead Electric

OE Kern River Gas Line, Existing

OE Existing Overhead Electrical Line

Groundwater Monitoring Well

Production Water Well

Existing Tower

Proposed Graded Feature

Project Boundary

All Locations Shown are Approximate

Utility Data, CH2MHill, March 2009
Project Area, Worley Parsons, Feb. 2009
Proposed Grading Areas, BrightSource, April 2009

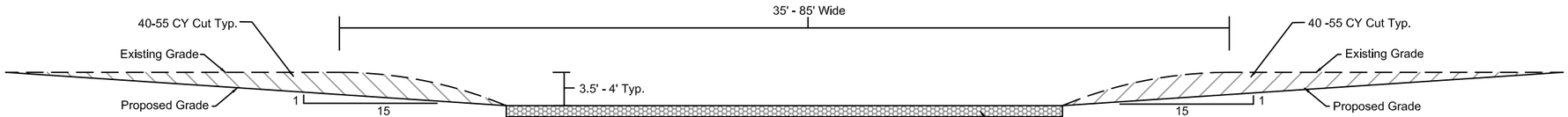
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	AB	KB	MC
A	3/23/09	Prelim Draft Issue	AB	KB	MC

FIGURE 21
UTILITY PLAN

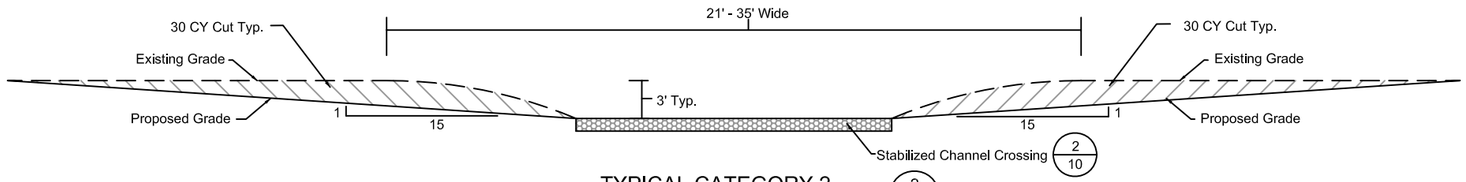
NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

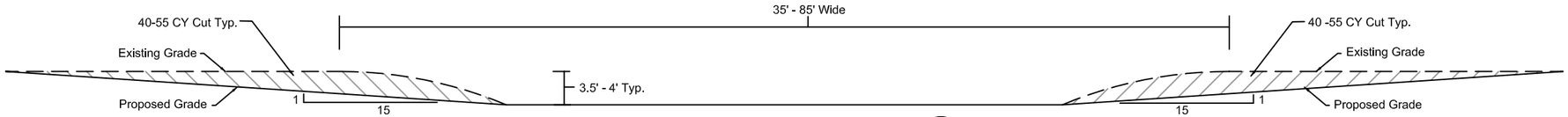
Date:
May 11, 2009



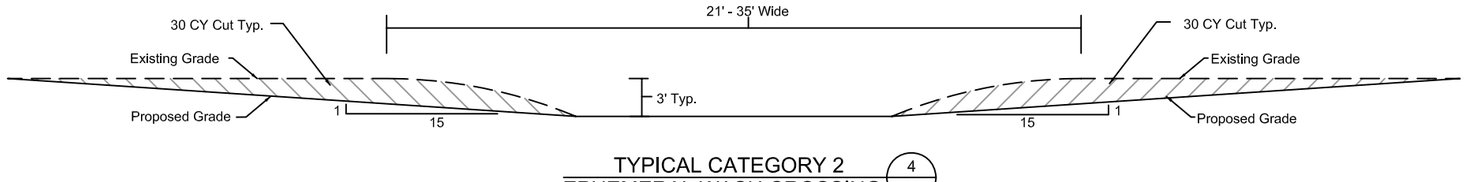
TYPICAL CATEGORY 1
STABILIZED CHANNEL CROSSING (1/22)
80 - 110 CUBIC YARD CUT TYPICAL
(NOT TO SCALE)



TYPICAL CATEGORY 2
STABILIZED CHANNEL CROSSING (2/22)
APPROXIMATELY 60 CUBIC YARD CUT TYPICAL
(NOT TO SCALE)



TYPICAL CATEGORY 1
EPHEMERAL WASH CROSSING (3/22)
80 - 110 CUBIC YARD CUT TYPICAL
(NOT TO SCALE)



TYPICAL CATEGORY 2
EPHEMERAL WASH CROSSING (4/22)
APPROXIMATELY 60 CUBIC YARD CUT TYPICAL
(NOT TO SCALE)

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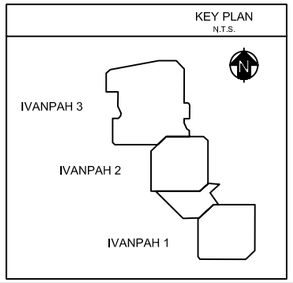
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

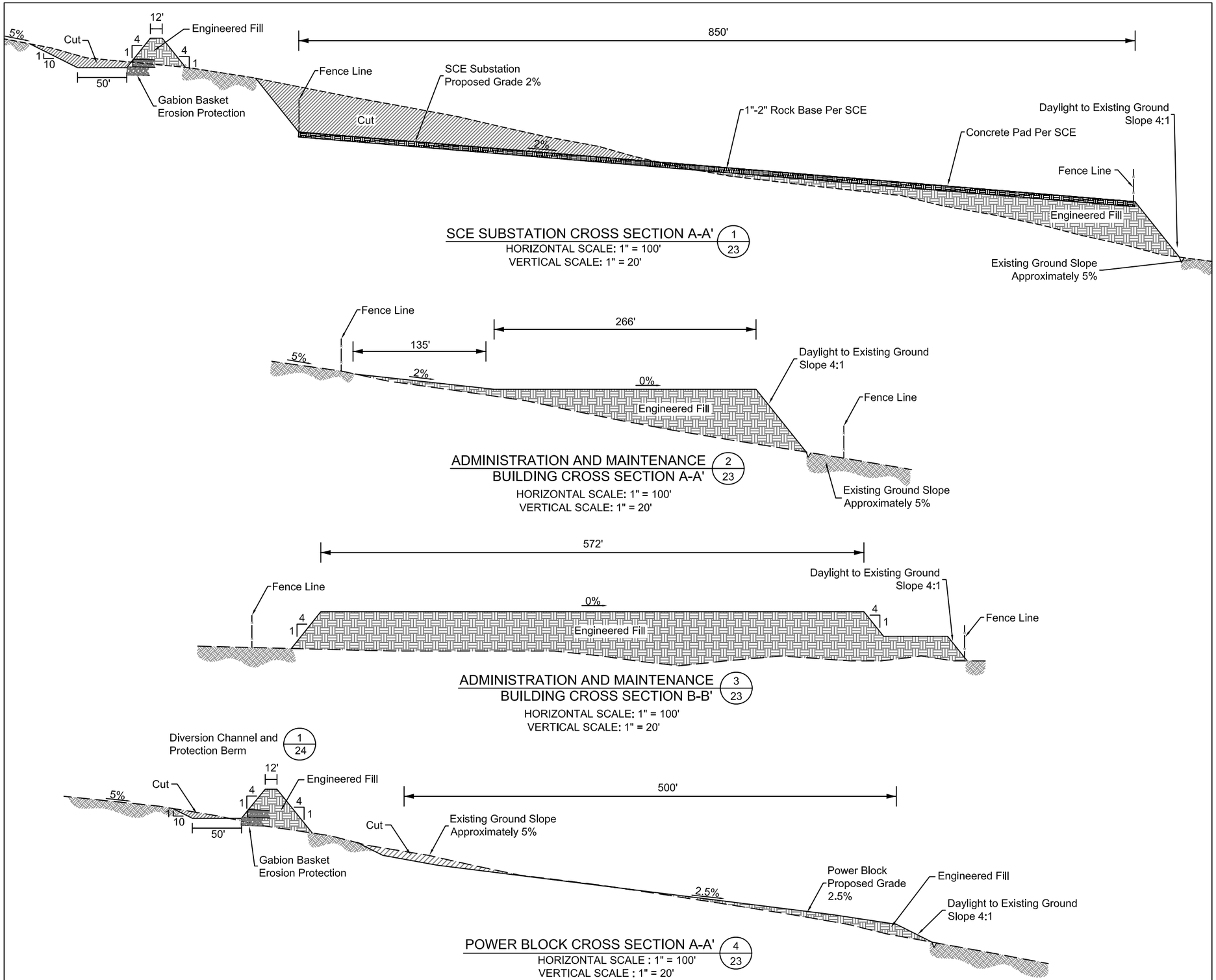
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC

FIGURE 22
TYPICAL CHANNEL CROSSING CROSS-SECTIONS

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

2009-05-11 v:\cadd\prj\brightsource\ivanpah\sheet_set_cad\figure_20_21_22_channel_crossing.dwg TtEMI-OAK stormzand, nathan



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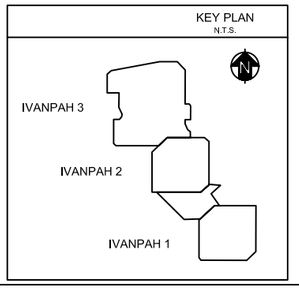


TETRA TECH

Horizontal Scale
0 50 100 200
Feet

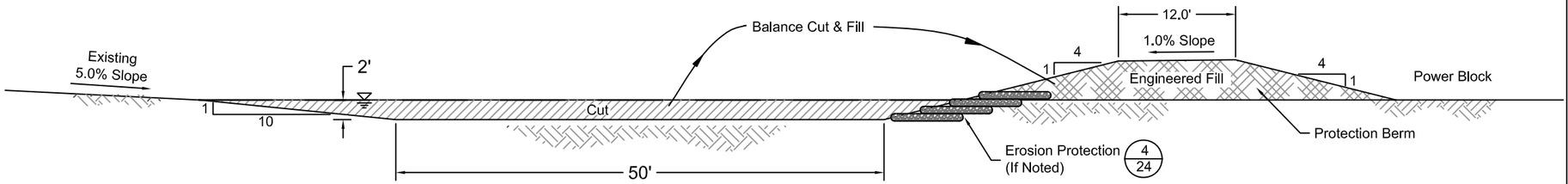
Vertical Scale
0 10 20 40
Feet

B	05/11/09	Attachments for DESCP	NS	BS	MC
A	03/23/09	Preliminary Draft Issue	NS	BS	MC
No.	Date	Description	Dsgn.	Chk.	App.

FIGURE 23
TYPICAL CROSS-SECTIONS

NOT ISSUED FOR CONSTRUCTION

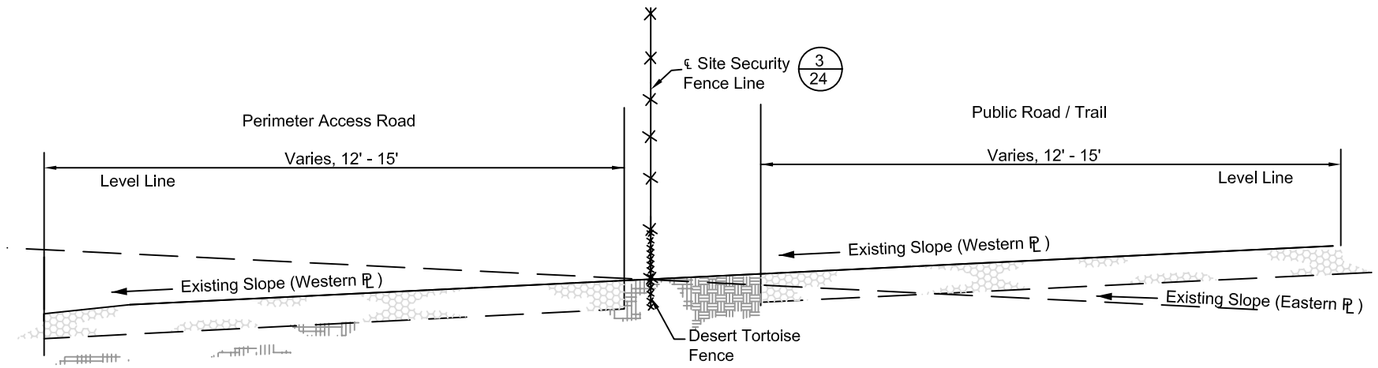
PROJECT #	May 11, 2009
106-3850	



DIVERSION CHANNEL AND PROTECTION BERM (1/24)

0 10 20 40

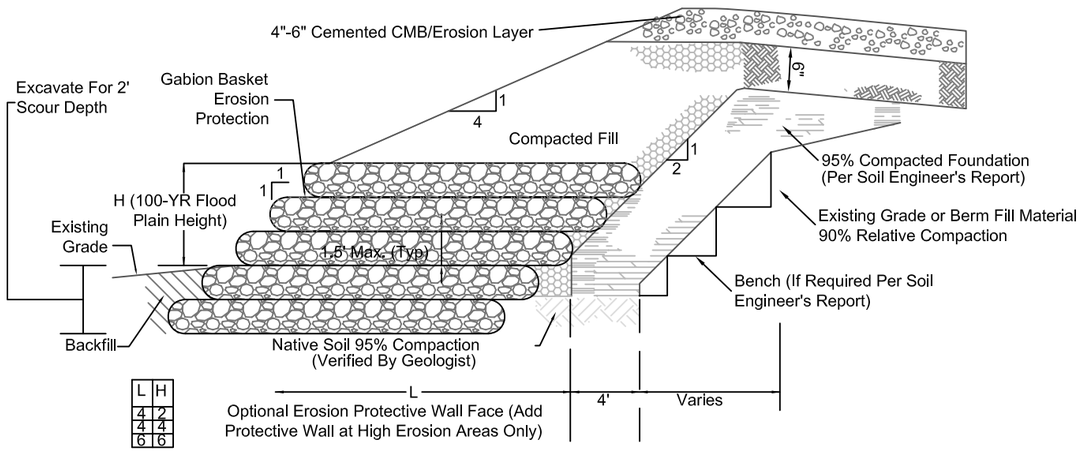
Feet



PERIMETER ACCESS ROAD AND FENCE (2/24)

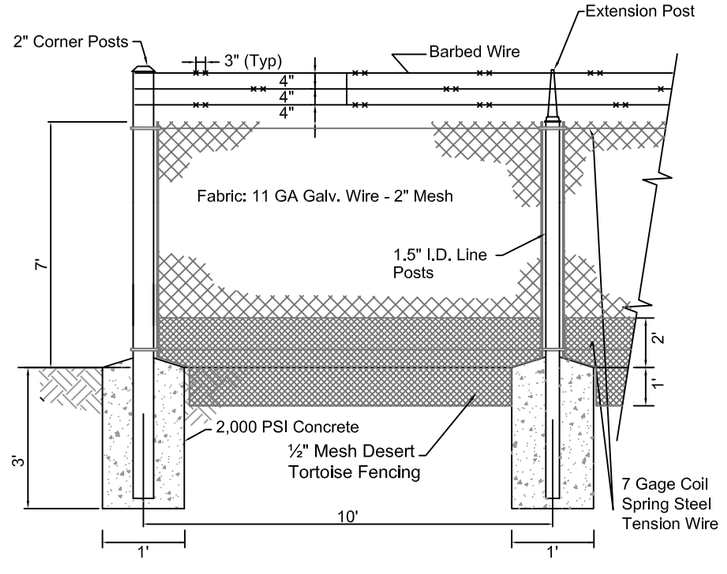
NOT TO SCALE

NOTE: SEE FIGURE 15 FOR ROADWAY PLAN



PROTECTION BERM (4/24)

NOT TO SCALE



TYPICAL PERIMETER FENCE DETAIL (3/24)

NOT TO SCALE

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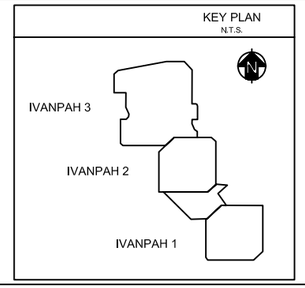


TETRA TECH

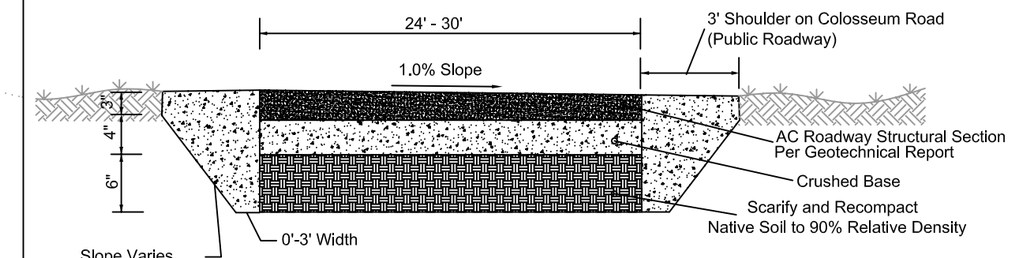
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	MC	BS
A	03/23/09	Preliminary Draft Issue	NS	MC	BS

FIGURE 24
TYPICAL DETAILS

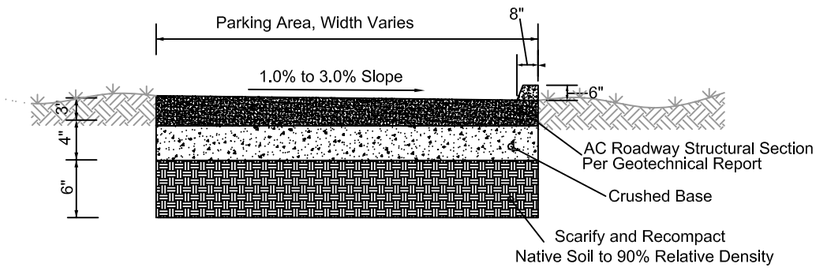
NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

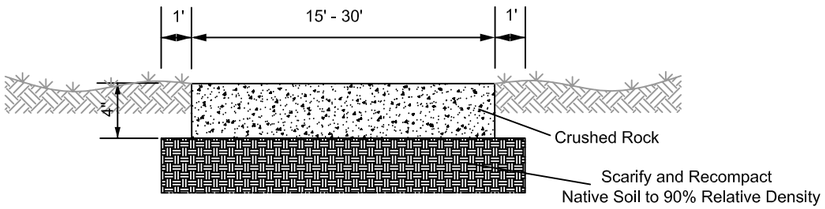
May 11, 2009



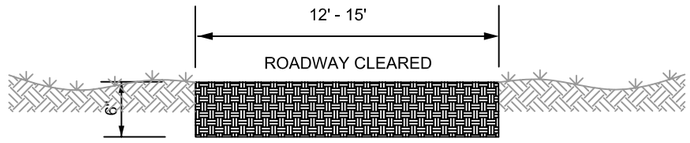
TYPICAL PAVED ROAD 1/25
NOT TO SCALE



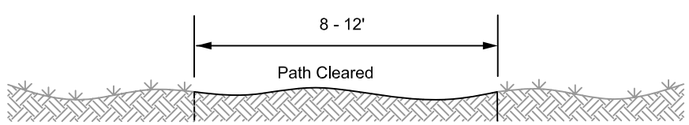
TYPICAL AC CURB AND GUTTER 2/25
NOT TO SCALE



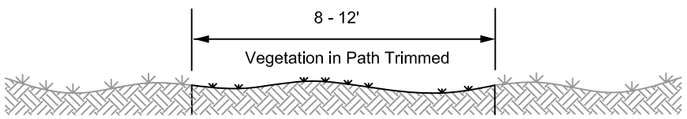
TYPICAL GRAVEL ROAD 3/25
NOT TO SCALE



TYPICAL DIRT ROAD 4/25
NOT TO SCALE



TYPICAL DIRT PATH 5/25
NOT TO SCALE



TYPICAL HELIOSTAT MAINTENANCE PATH 6/25
NOT TO SCALE

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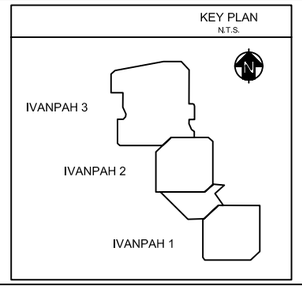
GENERATING SYSTEM PROJECT

SAN BERNARDINO COUNTY, CA



TETRA TECH

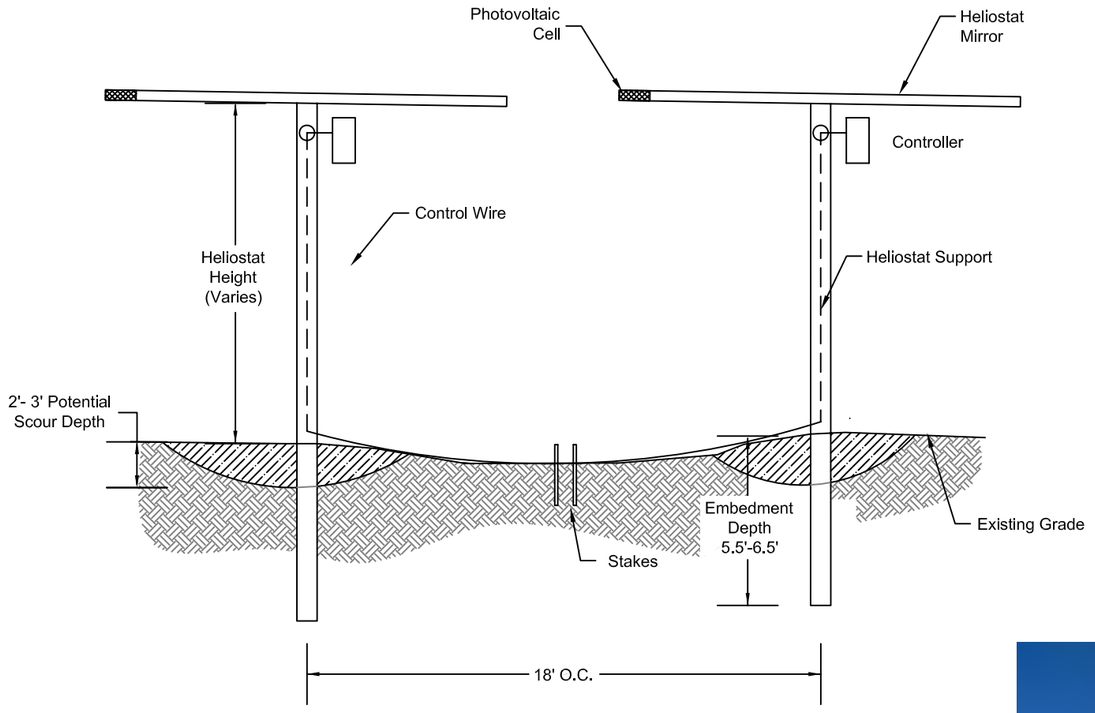
No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	MC	BS
A	03/23/09	Preliminary Draft Issue	NS	MC	BS

FIGURE 25
TYPICAL ROADWAY DETAILS

NOT ISSUED FOR CONSTRUCTION

PROJECT #
106-3850

May 11, 2009



TYPICAL HELIOSTAT DETAIL (1/26)
NOT TO SCALE

NOTE: EMBEDMENT DEPTH TO BE BASED ON SOILS REPORT AND STRUCTURAL REVIEW

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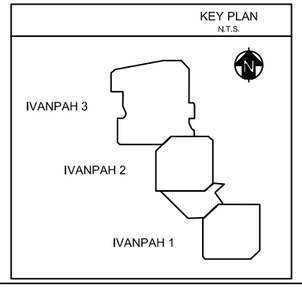
SAN BERNARDINO COUNTY, CA



TETRA TECH

No.	Date	Description	Dsgn.	Chk.	App.
B	05/11/09	Attachments for DESCP	NS	MC	BS
A	03/23/09	Preliminary Draft Issue	NS	MC	BS

FIGURE 26
TYPICAL HELIOSTAT DETAILS

NOT ISSUED FOR CONSTRUCTION

PROJECT #	
106-3850	May 11, 2009

IVANPAH 2

EXISTING COLOSSEUM ROAD

24'L x 12'W ENTRANCE/OUTLET TIRE WASH WITH SEDIMENT TRAP
TC-3

75"L x 20'W X 2'H CONCRETE WASTE MANAGEMENT
WM-8

COLOSSEUM ROAD

EXISTING TRANSMISSION CORRIDOR

UNDERGROUND WATER LINE WITH 20' EASEMENT, TYP.

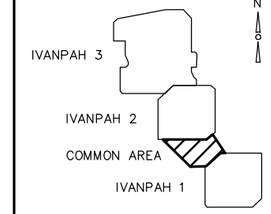
12' WIDE DIRT SITE ACCESS ROAD

30' WIDE PAVED ACCESS ROAD

EXISTING OVERHEAD ELECTRIC TRANSMISSION LINES

EXISTING OVERHEAD ELECTRIC TRANSMISSION TOWER

KEY PLAN
N.T.S.



LEGEND

- UNDERGROUND WATERLINE — W — W —
- UNDERGROUND GASLINE — GAS —
- 30' PAVED ROAD
- 12' LEVEL DIRT ROAD
- SITE BOUNDARY LINE
- COMBINED PERIMETER/TORTOISE FENCE —X—TF—X—
- EXISTING OVERHEAD ELECTRICAL — OE —

EROSION SEDIMENT CONTROL LEGEND

- CONCRETE WASTE MANAGEMENT — WM-8
- ENTRANCE/OUTLET TIRE WASH — TC-3

NORTH

60' 0 60' 120' 180'
APPROXIMATE SCALE IN FEET

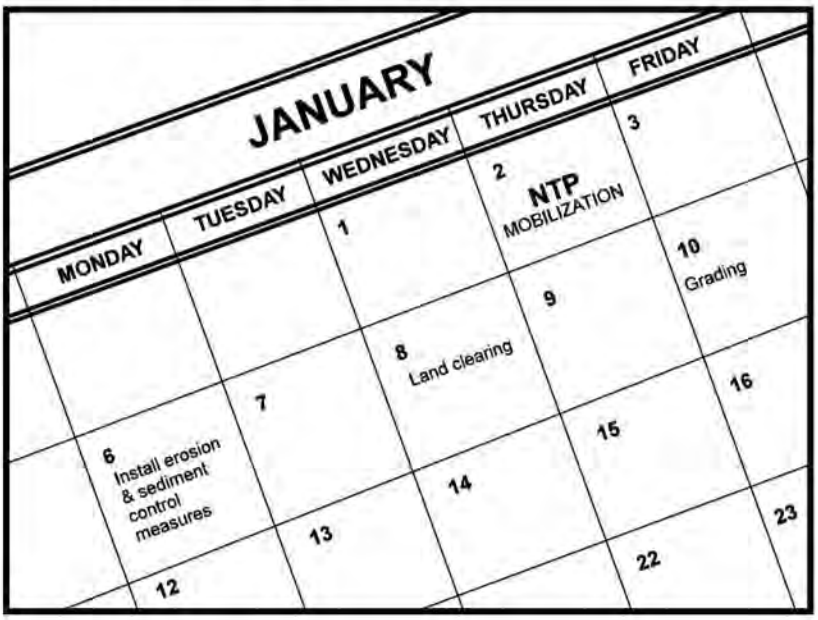
Source: WorleyParsons LTD, Drawing IVAN-0-SK-024-111-001A

FIGURE 27
TIRE WASH AND CONCRETE WASHOUT AREAS
IVANPAH SOLAR ELECTRIC GENERATING SYSTEM

CH2MHILL

ES062007009SAC Figure_DR140E-1.ai 08/04/08 dash

Scheduling EC-1



Objectives

EC	Erosion Control	☑
SE	Sediment Control	☒
TR	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.
- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates to soil

disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

Inspection and Maintenance

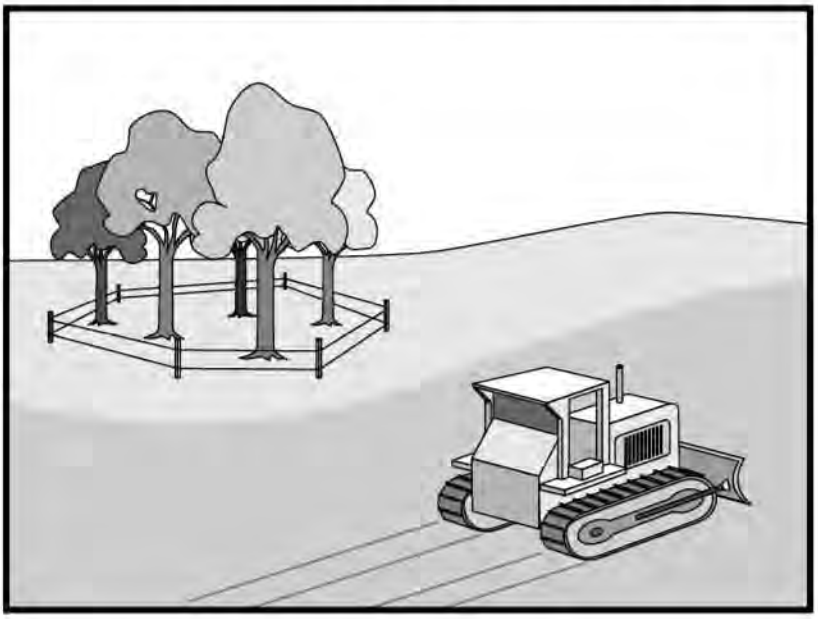
- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.

Preservation Of Existing Vegetation EC-2



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

EC-2 Preservation Of Existing Vegetation

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

- Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

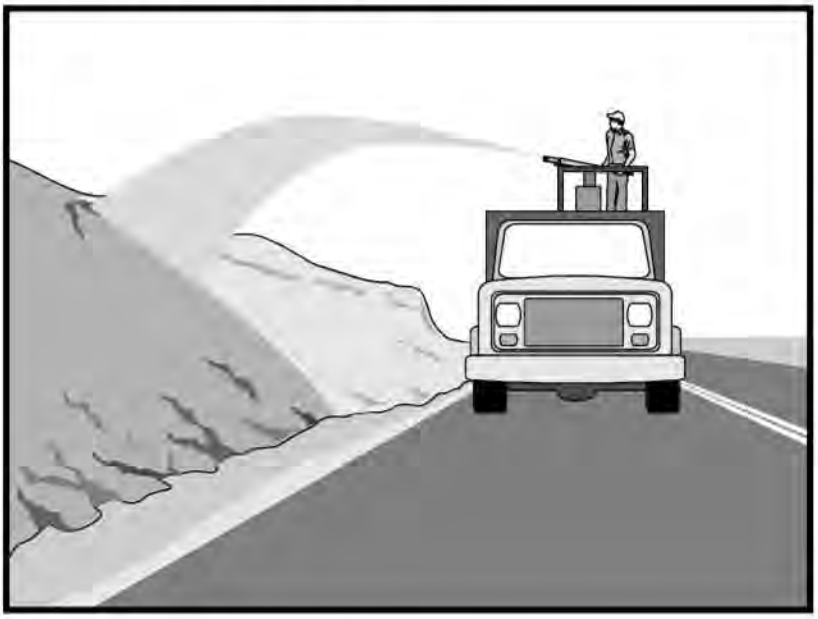
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydraulic Mulch EC-3



Objectives		
EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding
EC-5 Soil Binders
EC-6 Straw Mulch
EC-7 Geotextiles and Mats
EC-8 Wood Mulching

Description and Purpose

Hydraulic mulch consists of applying a mixture of shredded wood fiber or a hydraulic matrix, and a stabilizing emulsion or tackifier with hydro-mulching equipment, which temporarily protects exposed soil from erosion by raindrop impact or wind.

Suitable Applications

Hydraulic mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established, and disturbed areas that will be re-disturbed following an extended period of inactivity.

Limitations

Wood fiber hydraulic mulches are generally short lived and need 24 hours to dry before rainfall occurs to be effective. May require a second application in order to remain effective for an entire rainy season.

Implementation

- Prior to application, roughen embankment and fill areas by rolling with a crimping or punching type roller or by track walking. Track walking shall only be used where other methods are impractical.
- To be effective, hydraulic matrices require 24 hours to dry before rainfall occurs.
- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.

- Paper based hydraulic mulches alone shall not be used for erosion control.

Hydraulic Mulches

Wood fiber mulch can be applied alone or as a component of hydraulic matrices. Wood fiber applied alone is typically applied at the rate of 2,000 to 4,000 lb/acre. Wood fiber mulch is manufactured from wood or wood waste from lumber mills or from urban sources.

Hydraulic Matrices

Hydraulic matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder. Apply as a liquid slurry using a hydraulic application machine (i.e., hydro seeder) at the following minimum rates, or as specified by the manufacturer to achieve complete coverage of the target area: 2,000 to 4,000 lb/acre wood fiber mulch, and 5 to 10% (by weight) of tackifier (acrylic copolymer, guar, psyllium, etc.)

Bonded Fiber Matrix

Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFMs are typically applied at rates from 3,000 lb/acre to 4,000 lb/acre based on the manufacturer's recommendation. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFMs should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Costs

Average cost for installation of wood fiber mulch is $900/acre. Average cost for installation of BFM is $5,500/acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident shall be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.

References

Controlling Erosion of Construction Sites Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

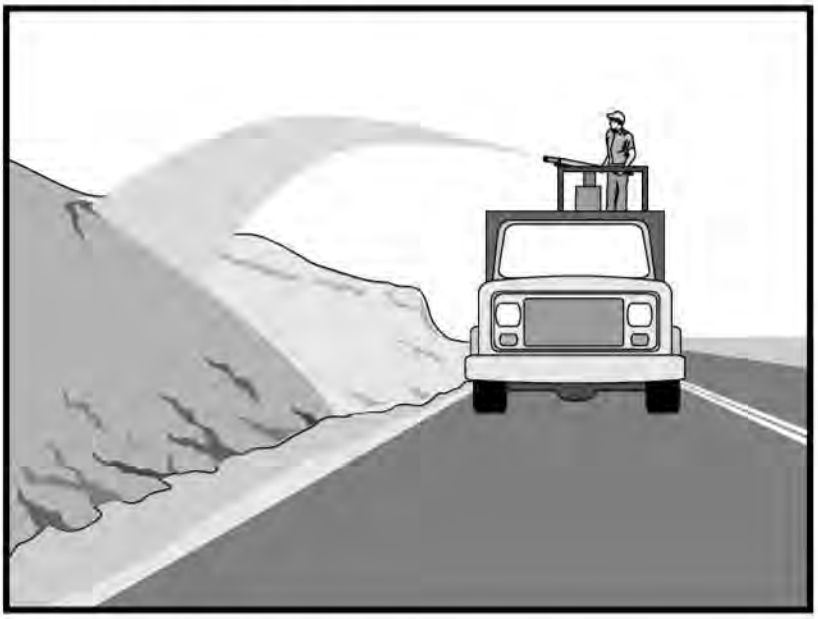
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Straw Mulch EC-6



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Straw mulch consists of placing a uniform layer of straw and incorporating it into the soil with a studded roller or anchoring it with a tackifier stabilizing emulsion. Straw mulch protects the soil surface from the impact of rain drops, preventing soil particles from becoming dislodged.

Suitable Applications

Straw mulch is suitable for soil disturbed areas requiring temporary protection until permanent stabilization is established. Straw mulch is typically used for erosion control on disturbed areas until soils can be prepared for permanent vegetation. Straw mulch is also used in combination with temporary and/or permanent seeding strategies to enhance plant establishment.

Limitations

- Availability of straw and straw blowing equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- There is a potential for introduction of weed seed and unwanted plant material.
- When straw blowers are used to apply straw mulch, the treatment areas must be within 150 ft of a road or surface capable of supporting trucks.
- Straw mulch applied by hand is more time intensive and potentially costly.

- Wind may limit application of straw and blow straw into undesired locations.
- May have to be removed prior to permanent seeding or prior to further earthwork.
- "Punching" of straw does not work in sandy soils, necessitating the use of tackifiers.

Implementation

- Straw shall be derived from wheat, rice, or barley. Where required by the plans, specifications, permits, or environmental documents, native grass straw shall be used.
- A tackifier is the preferred method for anchoring straw mulch to the soil on slopes.
- Crimping, punch roller-type rollers, or track walking may also be used to incorporate straw mulch into the soil on slopes. Track walking shall only be used where other methods are impractical.
- Avoid placing straw onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.
- Straw mulch with tackifier shall not be applied during or immediately before rainfall.
- In San Diego, use of straw near wood framed home construction has been frowned on by the Fire Marshall.

Application Procedures

- Apply straw at a minimum rate of 4,000 lb/acre, either by machine or by hand distribution.
- Roughen embankments and fill rills before placing the straw mulch by rolling with a crimping or punching type roller or by track walking.
- Evenly distribute straw mulch on the soil surface.
- Anchor straw mulch to the soil surface by "punching" it into the soil mechanically (incorporating). Alternatively, use a tackifier to adhere straw fibers.
- Methods for holding the straw mulch in place depend upon the slope steepness, accessibility, soil conditions, and longevity.
  - On small areas, a spade or shovel can be used to punch in straw mulch.
  - On slopes with soils that are stable enough and of sufficient gradient to safely support construction equipment without contributing to compaction and instability problems, straw can be "punched" into the ground using a knife blade roller or a straight bladed coulter, known commercially as a "crimper".
  - On small areas and/or steep slopes, straw can also be held in place using plastic netting or jute. The netting shall be held in place using 11 gauge wire staples, geotextile pins or wooden stakes as described in EC-7, Geotextiles and Mats.
  - A tackifier acts to glue the straw fibers together and to the soil surface. The tackifier shall be selected based on longevity and ability to hold the fibers in place. A tackifier is

typically applied at a rate of 125 lb/acre. In windy conditions, the rates are typically 180 lb/acre.

Costs

Average annual cost for installation and maintenance (3-4 months useful life) is $2,500 per acre. Application by hand is more time intensive and potentially costly.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- The key consideration in inspection and maintenance is that the straw needs to last long enough to achieve erosion control objectives.
- Maintain an unbroken, temporary mulched ground cover while disturbed soil areas are inactive. Repair any damaged ground cover and re-mulch exposed areas.
- Reapplication of straw mulch and tackifier may be required to maintain effective soil stabilization over disturbed areas and slopes.

References

Controlling Erosion of Construction Sites, Agricultural Information Bulletin #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

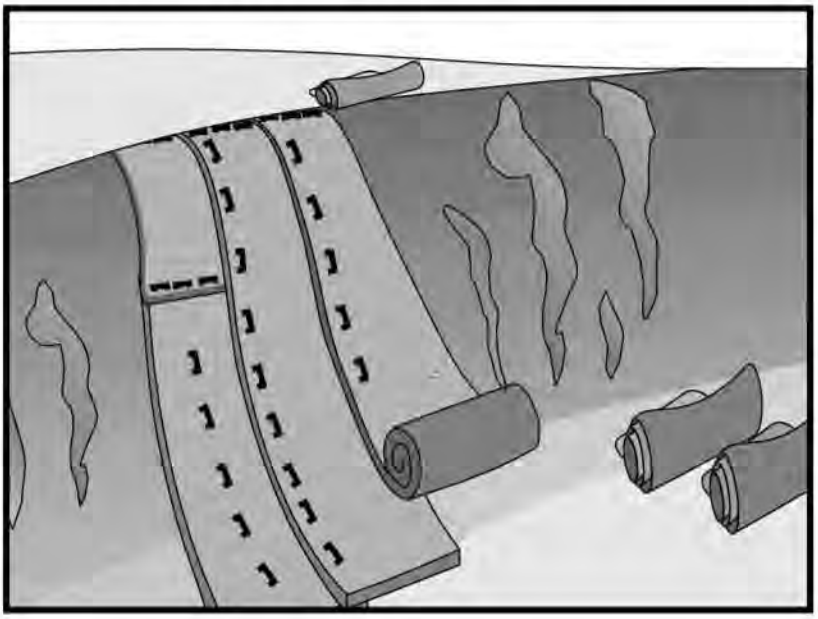
Soil Erosion by Water, Agricultural Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Geotextiles and Mats EC-7



Objectives		
EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	3
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch
EC-4 Hydroseeding
EC-5 Soil Binders
EC-6 Straw Mulch
EC-8 Wood Mulching

Description and Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 ft/s and 6 ft/s are likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive. These measures should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop
- Channels with flows exceeding 3.3 ft/s

- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs)

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and Mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

The following natural and synthetic mattings are commonly used:

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil.

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples

should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

- **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.

- Grade and shape the area of installation.

- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.

- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket

installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.

- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.

- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.

- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.

- Unroll blanket down slope in the direction of water flow.

- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.

- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.

- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Relatively high compared to other BMPs. Biodegradable materials: $0.50 - $0.57/yd^2. Permanent materials: $3.00 - $4.50/yd^2. Staples: $0.04 - $0.05/staple. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre
Biodegradable	Jute Mesh	$6,500
	Curled Wood Fiber	$10,500
	Straw	$8,900
	Wood Fiber	$8,900
	Coconut Fiber	$13,000
	Coconut Fiber Mesh	$31,200
	Straw Coconut Fiber	$10,900
Non-Biodegradable	Plastic Netting	$2,000
	Plastic Mesh	$3,200
	Synthetic Fiber with Netting	$34,800
	Bonded Synthetic Fibers	$50,000
	Combination with Biodegradable	$32,000

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

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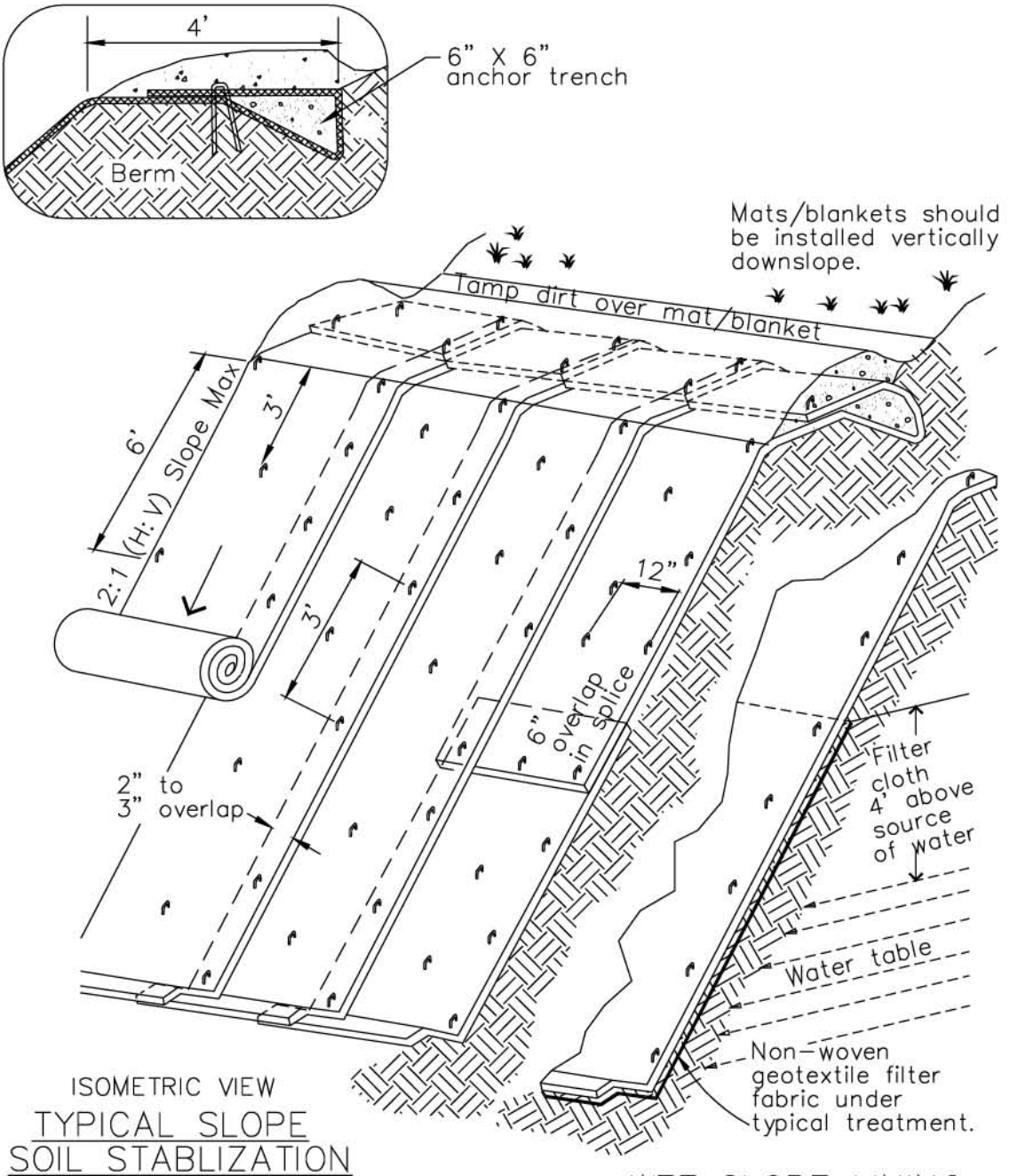


ISOMETRIC VIEW

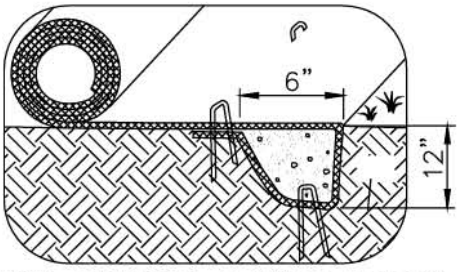
TYPICAL SLOPE
SOIL STABLIZATION
NTS

WET SLOPE LINING
NTS

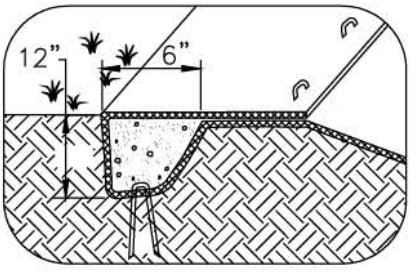
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL



INITIAL CHANNEL ANCHOR TRENCH
NTS



TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
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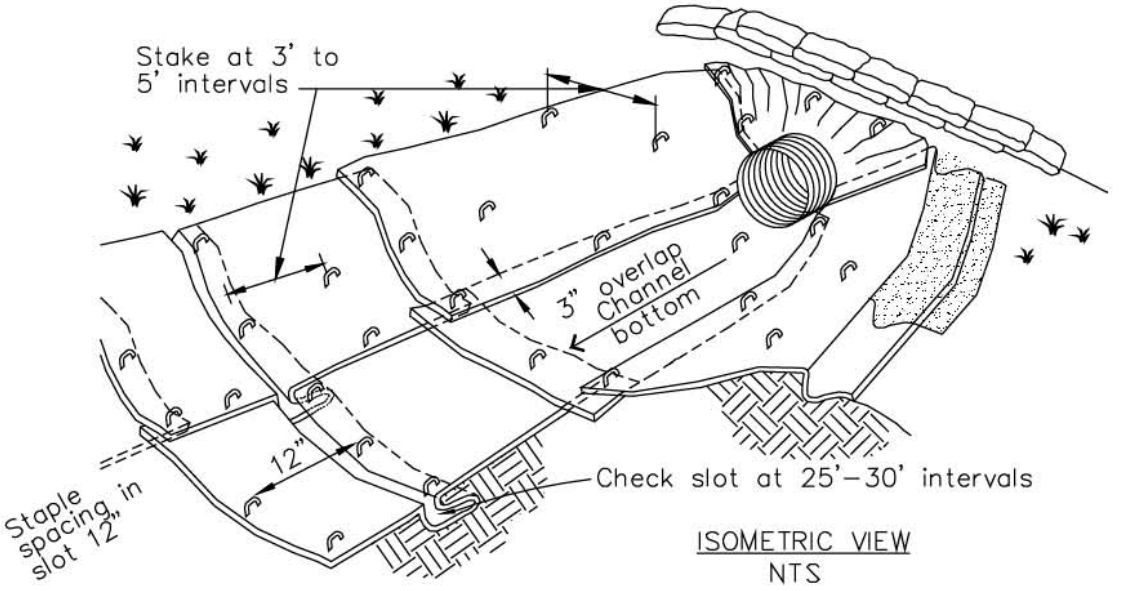
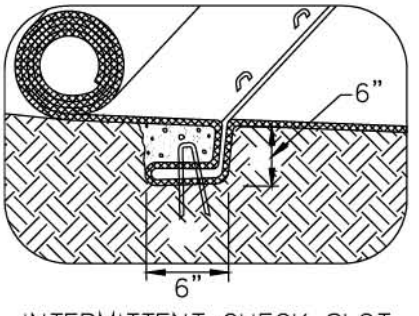
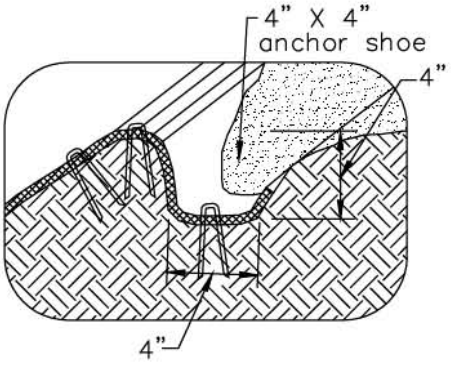


ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS

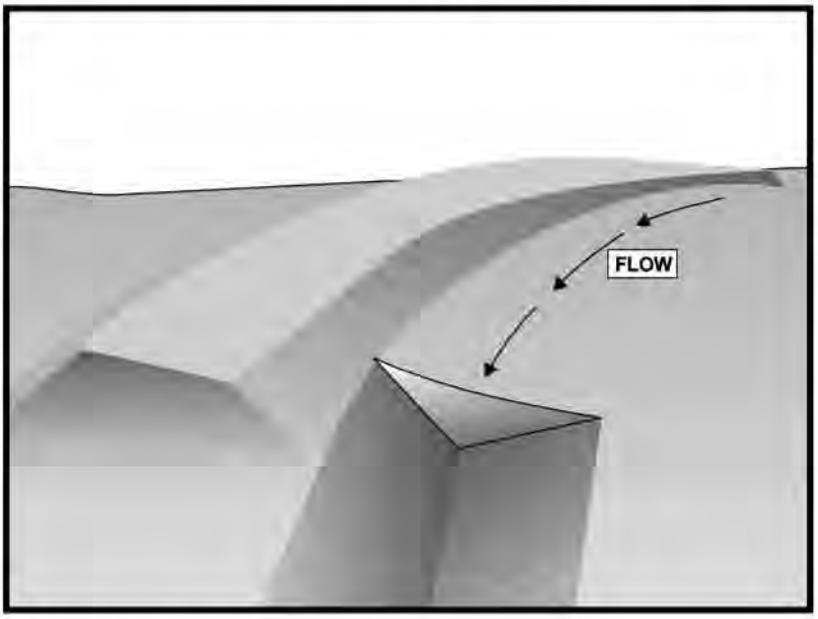


LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL

Earth Dikes and Drainage Swales EC-9



Objectives		
EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives
None

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and

compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.

- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.
- Construct the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/$yd^3$.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

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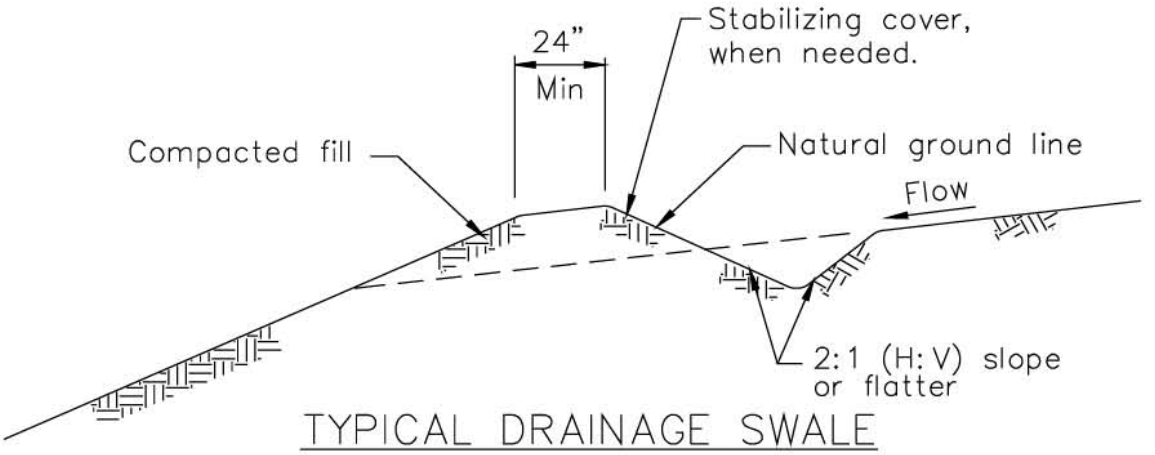
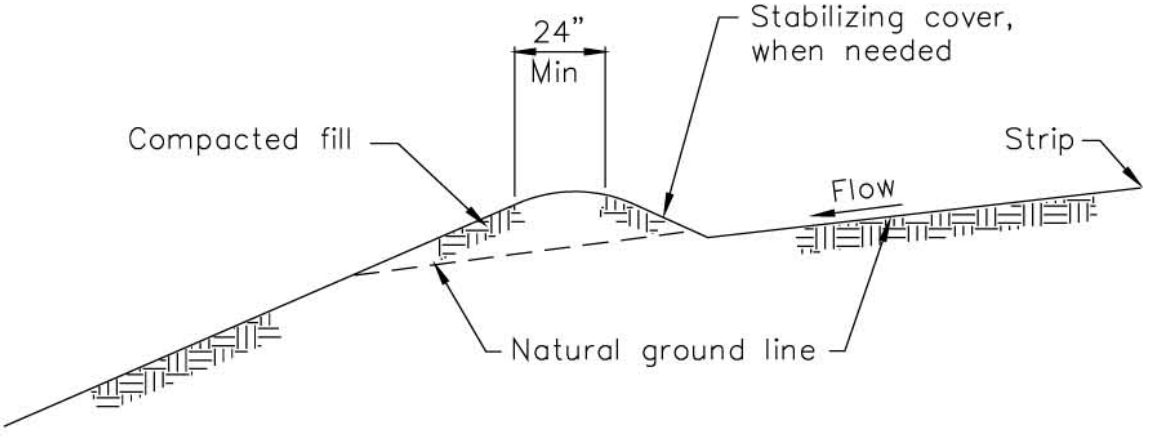


TYPICAL DRAINAGE SWALE
NOT TO SCALE

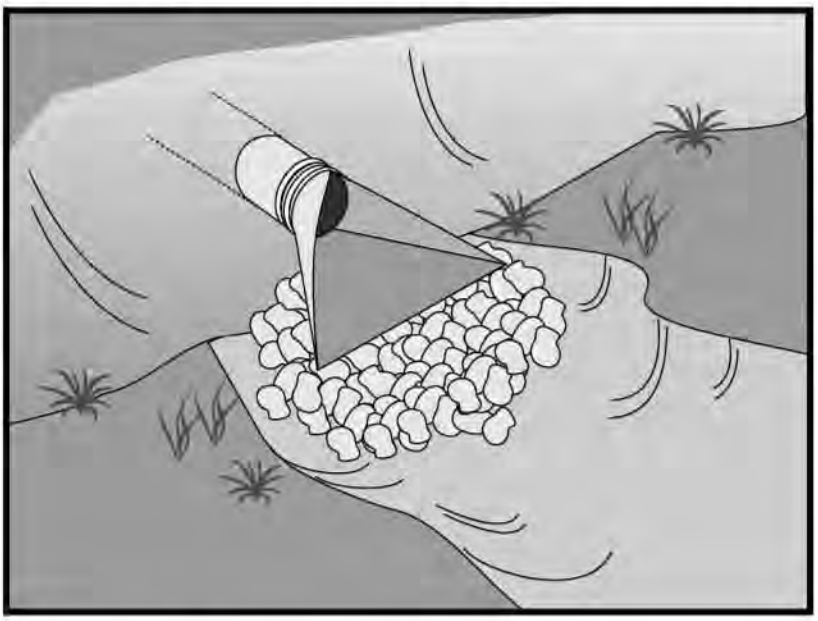
NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE

Velocity Dissipation Devices EC-10



Objectives		
EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.

- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.
    - Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
    - Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.

- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.

- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur.

- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.

- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.

- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

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Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

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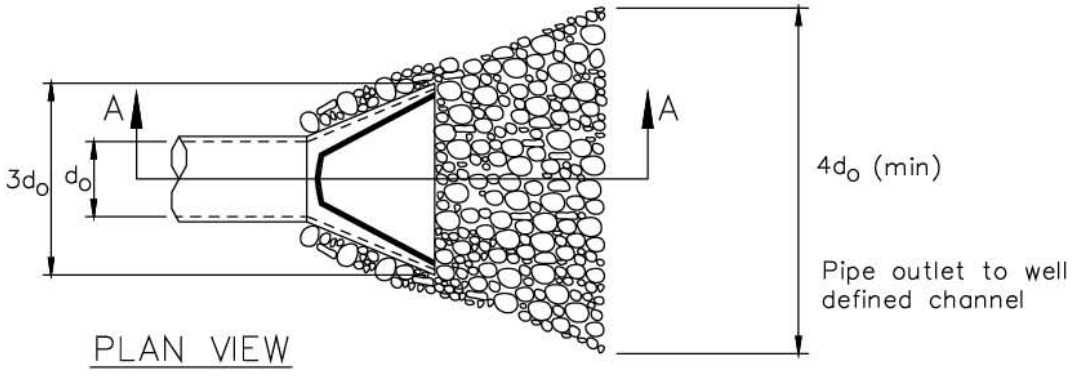
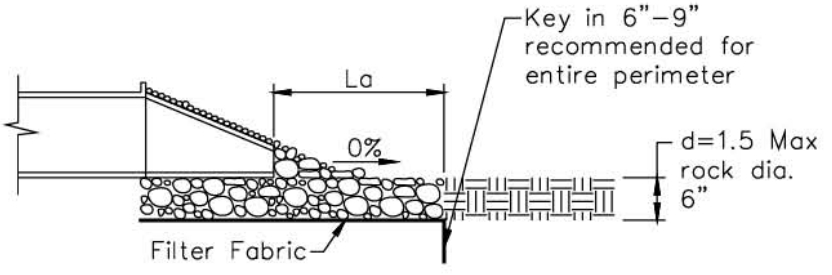


PLAN VIEW



SECTION A–A

Pipe Diameter inches	Discharge ft^3/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Streambank Stabilization EC-12

Objectives

EC	Erosion Control	☑
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

Combination of erosion and sediment controls.

Description and Purpose

Stream channels, streambanks, and associated riparian areas are dynamic and sensitive ecosystems that respond to changes in land use activity. Streambank and channel disturbance resulting from construction activities can increase the stream's sediment load, which can cause channel erosion or sedimentation and have adverse affects on the biotic system. BMPs can reduce the discharge of sediment and other pollutants to minimize the impact of construction activities on watercourses. Streams on the 303(d) list and listed for sediment may require numerous measures to prevent any increases in sediment load to the stream.

Suitable Applications

These procedures typically apply to all construction projects that disturb or occur within stream channels and their associated riparian areas.

Limitations

Specific permit requirements or mitigation measures such as Regional Water Quality Control Board (RWQCB) 401 Certification, U.S. Army Corps of Engineers 404 permit and approval by California Department of Fish and Game supercede the guidance in this BMP.

- If numerical based water quality standards are mentioned in any of these and other related permits, testing and sampling may be required. Streams listed as 303(d) impaired for sediment, silt, or turbidity, are required to conduct sampling

to verify that there is no net increase in sediment load due to construction activities.

Implementation

Planning

- Proper planning, design, and construction techniques can minimize impacts normally associated with in stream construction activities. Poor planning can adversely affect soil, fish, wildlife resources, land uses, or land users. Planning should take into account: scheduling; avoidance of in-stream construction; minimizing disturbance area and construction time period; using pre-disturbed areas; selecting crossing location; and selecting equipment.

Scheduling

- Construction activities should be scheduled according to the relative sensitivity of the environmental concerns and in accordance with EC-1, Scheduling. Scheduling considerations will be different when working near perennial streams vs. ephemeral streams and are as follows.

- When in-stream construction is conducted in a perennial stream, work should optimally be performed during the rainy season. This is because in the summer, any sediment-containing water that is discharged into the watercourse will cause a large change in both water clarity and water chemistry. During the rainy season, there is typically more and faster flowing water in the stream so discharges are diluted faster. However, should in-stream work be scheduled for summer, establishing an isolation area, or diverting the stream, will significantly decrease the amount of sediment stirred up by construction work. Construction work near perennial streams should optimally be performed during the dry season (see below).

- When working in or near ephemeral streams, work should be performed during the dry season. By their very nature, ephemeral streams are usually dry in the summer, and therefore, in-stream construction activities will not cause significant water quality problems. However, when tying up the site at the end of the project, wash any fines (see Washing Fines) that accumulated in the channel back into the bed material, to decrease pollution from the first rainstorm of the season.

- When working near ephemeral or perennial streams, erosion and sediment controls (see silt fences, straw bale barriers, etc.) should be implemented to keep sediment out of stream channel.

Minimize Disturbance

- Minimize disturbance through: selection of the narrowest crossing location; limiting the number of equipment trips across a stream during construction; and, minimizing the number and size of work areas (equipment staging areas and spoil storage areas). Place work areas at least 50 ft from stream channel. Field reconnaissance should be conducted during the planning stage to identify work areas.

Use of Pre-Disturbed Areas

- Locate project sites and work areas in areas disturbed by prior construction or other activity when possible.

Selection of Project Site

- Avoid steep and unstable banks, highly erodible or saturated soils, or highly fractured rock.
- Select project site that minimizes disturbance to aquatic species or habitat.

Equipment Selection

- Select equipment that reduces the amount of pressure exerted on the ground surface, and therefore, reduces erosion potential and/or use overhead or aerial access for transporting equipment across drainage channels. Use equipment that exerts ground pressures of less than 5 or 6 lb/in^2, where possible. Low ground pressure equipment includes: wide or high flotation tires (34 to 72 in. wide); dual tires; bogie axle systems; tracked machines; lightweight equipment; and, central tire inflation systems.

Streambank Stabilization

Preservation of Existing Vegetation

- Preserve existing vegetation in accordance with EC-2, Preservation of Existing Vegetation. In a streambank environment, preservation of existing vegetation provides the following benefits.

Water Quality Protection

- Vegetated buffers on slopes trap sediment and promote groundwater recharge. The buffer width needed to maintain water quality ranges from 15 to 100 ft. On gradual slopes, most of the filtering occurs within the first 30 ft. Steeper slopes require a greater width of vegetative buffer to provide water quality benefits.

Streambank Stabilization

- The root system of riparian vegetation stabilizes streambanks by increasing tensile strength in the soil. The presence of vegetation modifies the moisture condition of slopes (infiltration, evapo transpiration, interception) and increases bank stability.

Riparian Habitat

- Buffers of diverse riparian vegetation provide food and shelter for riparian and aquatic organisms. Minimizing impacts to fisheries habitat is a major concern when working near streams and rivers. Riparian vegetation provides shade, shelter, organic matter (leaf detritus and large woody debris), and other nutrients that are necessary for fish and other aquatic organisms. Buffer widths for habitat concerns are typically wider than those recommended for water quality concerns (100 to 1500 ft).
- When working near watercourses, it is important to understand the work site's placement in the watershed. Riparian vegetation in headwater streams has a greater impact on overall water quality than vegetation in downstream reaches. Preserving existing vegetation upstream is necessary to maintain water quality, minimize bank failure, and maximize riparian habitat, downstream of the work site.

Limitations

- Local county and municipal ordinances regarding width, extent and type of vegetative buffer required may exceed the specifications provided here; these ordinances should be investigated prior to construction.

Streambank Stabilization Specific Installation

- As a general rule, the width of a buffer strip between a road and the stream is recommended to be 50 ft plus four times the percent slope of the land, measured between the road and the top of stream bank.

Hydraulic Mulch

- Apply hydraulic mulch on disturbed streambanks above mean high water level in accordance with EC-3, Hydraulic Mulch to provide temporary soil stabilization.

Limitations

- Do not place hydraulic mulch or tackifiers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication (eutrophication is an algal bloom caused by excessively high nutrient levels in the water).

Hydroseeding

- Hydroseed disturbed streambanks in accordance with EC-4, Hydroseeding.

Limitations

- Do not place tackifiers or fertilizers below the mean high water level, as these materials could wash into the channel and impact water quality or possibly cause eutrophication.

Soil Binders

- Apply soil binders to disturbed streambanks in accordance with EC-5, Soil Binders.

Limitations

- Do not place soil binders below the mean high water level. Soil binder must be environmentally benign and non-toxic to aquatic organisms.

Straw Mulch

- Apply straw mulch to disturbed streambanks in accordance with EC-6, Straw Mulch.

Limitations

- Do not place straw mulch below the mean high water level, as this material could wash into the channel and impact water quality or possibly cause eutrophication.

Geotextiles and Mats

- Install geotextiles and mats as described in EC-7, Geotextiles and Mats, to stabilize disturbed channels and streambanks. Not all applications should be in the channel, for example, certain geotextile netting may snag fish gills and are not appropriate in fish bearing streams. Geotextile fabrics that are not biodegradable are not appropriate for in stream use. Additionally, geotextile fabric or blankets placed in channels must be adequate to sustain anticipated hydraulic forces.

Earth Dikes, Drainage Swales, and Lined Ditches

- Convey, intercept, or divert runoff from disturbed streambanks using EC-9, Earth Dikes and Drainage Swales.

Limitations

- Do not place earth dikes in watercourses, as these structures are only suited for intercepting sheet flow, and should not be used to intercept concentrated flow.

- Appropriately sized velocity dissipation devices (EC-10) must be placed at outlets to minimize erosion and scour.

Velocity Dissipation Devices

- Place velocity dissipation devices at outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits or channels in accordance with EC-10, Velocity Dissipation Devices.

Slope Drains

- Use slope drains to intercept and direct surface runoff or groundwater into a stabilized watercourse, trapping device or stabilized area in accordance with EC-11, Slope Drains.

Limitations

- Appropriately sized outlet protection and velocity dissipation devices (EC-10) must be placed at outlets to minimize erosion and scour.

Streambank Sediment Control

Silt Fences

- Install silt fences in accordance with SE-1, Silt Fence, to control sediment. Silt fences should only be installed where sediment laden water can pond, thus allowing the sediment to settle out.

Fiber Rolls

- Install fiber rolls in accordance with SE-5, Fiber Rolls, along contour of slopes above the high water level to intercept runoff, reduce flow velocity, release the runoff as sheet flow and provide removal of sediment from the runoff. In a stream environment, fiber rolls should be used in conjunction with other sediment control methods such as SE-1, Silt Fence or SE-9 Straw Bale Barrier. Install silt fence, straw bale barrier, or other erosion control method along toe of slope above the high water level.

Gravel Bag Berm

- A gravel bag berm or barrier can be utilized to intercept and slow the flow of sediment laden sheet flow runoff in accordance with SE-6, Gravel Bag Berm. In a stream environment gravel bag barriers can allow sediment to settle from runoff before water leaves the construction site and can be used to isolate the work area from the live stream.

Limitations

- Gravel bag barriers are not recommended as a perimeter sediment control practice around streams.

Straw Bale Barrier

- Install straw bale barriers in accordance with SE-9, Straw Bale Barrier, to control sediment. Straw bale barriers should only be installed where sediment laden water can pond, thus allowing the sediment to settle out. Install a silt fence in accordance with SE-1, Silt Fence,

on down slope side of straw bale barrier closest to stream channel to provide added sediment control.

Rock Filter

Description and Purpose

Rock filters are temporary erosion control barriers composed of rock that is anchored in place. Rock filters detain the sediment laden runoff, retain the sediment, and release the water as sheet flow at a reduced velocity. Typical rock filter installations are illustrated at the end of this BMP.

Applications

- Near the toe of slopes that may be subject to flow and rill erosion.

Limitations

- Inappropriate for contributing drainage areas greater than 5 acres.
- Requires sufficient space for ponded water.
- Ineffective for diverting runoff because filters allow water to slowly seep through.
- Rock filter berms are difficult to remove when construction is complete.
- Unsuitable in developed areas or locations where aesthetics is a concern.

Specifications

- Rock: open graded rock, 0.75 to 5 in. for concentrated flow applications.
- Woven wire sheathing: 1 in. diameter, hexagonal mesh, galvanized 20gauge (used with rock filters in areas of concentrated flow).
- In construction traffic areas, maximum rock berm heights should be 12 in. Berms should be constructed every 300 ft on slopes less than 5%, every 200 ft on slopes between 5% and 10%, and every 100 ft on slopes greater than 10%.

Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Reshape berms as needed and replace lost or dislodged rock, and filter fabric.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.

K-rail

Description and Purpose

This is temporary sediment control that uses K-rails to form the sediment deposition area, or to isolate the near bank construction area. Install K-rails at toe of slope in accordance with procedures described in NS-5, Clear Water Diversion.

Barriers are placed end to end in a pre-designed configuration and gravel filled bags are used at the toe of the barrier and at their abutting ends to seal and prevent movement of sediment beneath or through the barrier walls.

Appropriate Applications

- This technique is useful at the toe of embankments, cuts or fills slopes.

Limitations

- The K-rail method should not be used to dewater a project site, as the barrier is not watertight.

Implementation

- Refer to NS-5, Clear Water Diversion, for implementation requirements.

Instream Construction Sediment Control

There are three different options currently available for reducing turbidity while working in a stream or river. The stream can be isolated from the area in which work is occurring by means of a water barrier, the stream can be diverted around the work site through a pipe or temporary channel, or one can employ construction practices that minimize sediment suspension.

Whatever technique is implemented, an important thing to remember is that dilution can sometimes be the solution. A probable "worst time" to release high TSS into a stream system might be when the stream is very low; summer low flow, for example. During these times, the flow may be low while the biological activity in the stream is very high. Conversely, the addition of high TSS or sediment during a big storm discharge might have a relatively low impact, because the stream is already turbid, and the stream energy is capable of transporting both suspended solids, and large quantities of bedload through the system. The optimum time to "pull" in-stream structures may be during the rising limb of a storm hydrograph.

Techniques to minimize Total Suspended Solids (TSS)

- **Padding** - Padding laid in the stream below the work site may trap some solids that are deposited in the stream during construction. After work is done, the padding is removed from the stream, and placed on the bank to assist in re-vegetation.

- **Clean, washed gravel** - Using clean, washed gravel decreases solid suspension, as there are fewer small particles deposited in the stream.

- **Excavation using a large bucket** - Each time a bucket of soil is placed in the stream, a portion is suspended. Approximately the same amount is suspended whether a small amount of soil is placed in the stream, or a large amount. Therefore, using a large excavator bucket instead of a small one, will reduce the total amount of soil that washes downstream.

- **Use of dozer for backfilling** - Using a dozer for backfilling instead of a backhoe follows the same principles – the fewer times soil is deposited in the stream, the less soil will be suspended.

- **Partial dewatering with a pump** - Partially dewatering a stream with a pump reduces the amount of water, and thus the amount of water that can suspend sediment.

Washing Fines

Definition and Purpose

- Washing fines is an "in-channel" sediment control method, which uses water, either from a water truck or hydrant, to wash stream fines that were brought to the surface of the channel bed during restoration, back into the interstitial spaces of the gravel and cobbles.

- The purpose of this technique is to reduce or eliminate the discharge of sediment from the channel bottom during the first seasonal flow. Sediment should not be allowed into stream channels; however, occasionally in-channel restoration work will involve moving or otherwise disturbing fines (sand and silt sized particles) that are already in the stream, usually below bankfull discharge elevation. Subsequent re-watering of the channel can result in a plume of turbidity and sedimentation.

- This technique washes the fines back into the channel bed. Bedload materials, including gravel cobbles, boulders and those fines, are naturally mobilized during higher storm flows. This technique is intended to delay the discharge until the fines would naturally be mobilized.

Appropriate Applications

- This technique should be used when construction work is required in channels. It is especially useful in intermittent or ephemeral streams in which work is performed "in the dry", and which subsequently become re-watered.

Limitations

- The stream must have sufficient gravel and cobble substrate composition.

- The use of this technique requires consideration of time of year and timing of expected stream flows.

- The optimum time for the use of this technique is in the fall, prior to winter flows.

- Consultation with, and approval from the Department of Fish and Game and the Regional Water Quality Control Board may be required.

Implementation

- Apply sufficient water to wash fines, but not cause further erosion or runoff.

- Apply water slowly and evenly to prevent runoff and erosion.

- Consult with Department of Fish and Game and the Regional Water Quality Control Board for specific water quality requirements of applied water (e.g. chlorine).

Inspection and Maintenance

- None necessary

Costs

Cost may vary according to the combination of practices implemented.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect and repair equipment (for damaged hoses, fittings, and gaskets).

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

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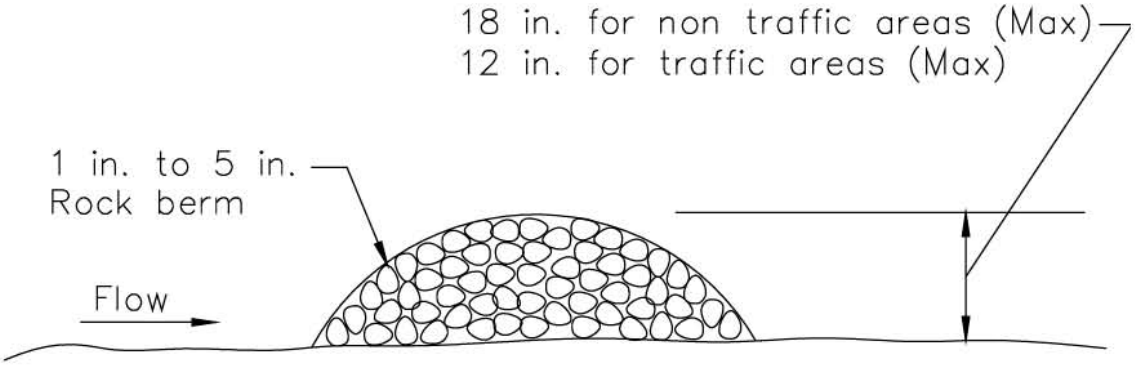
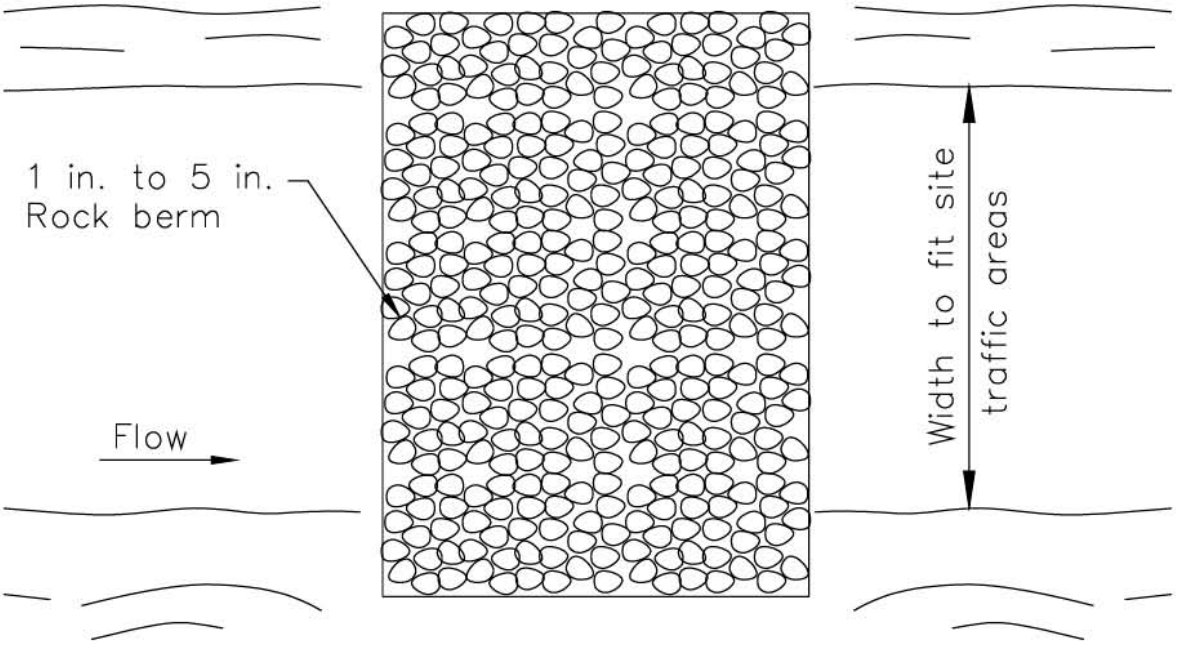


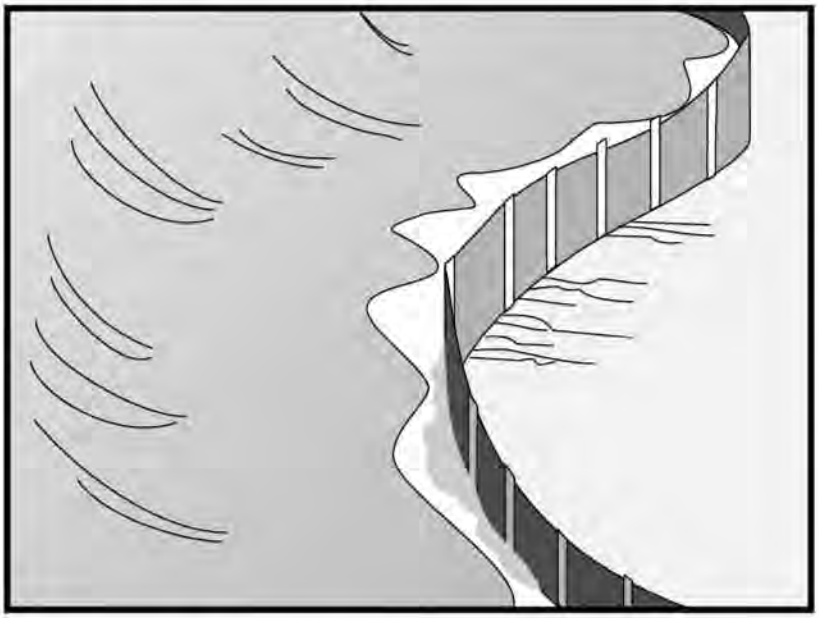
SECTION



PLAN

TYPICAL ROCK FILTER
NOT TO SCALE

Silt Fence SE-1



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don't use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.

- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85 % of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line the proposed silt fence.

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated. Filter fabric should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with compacted native material.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

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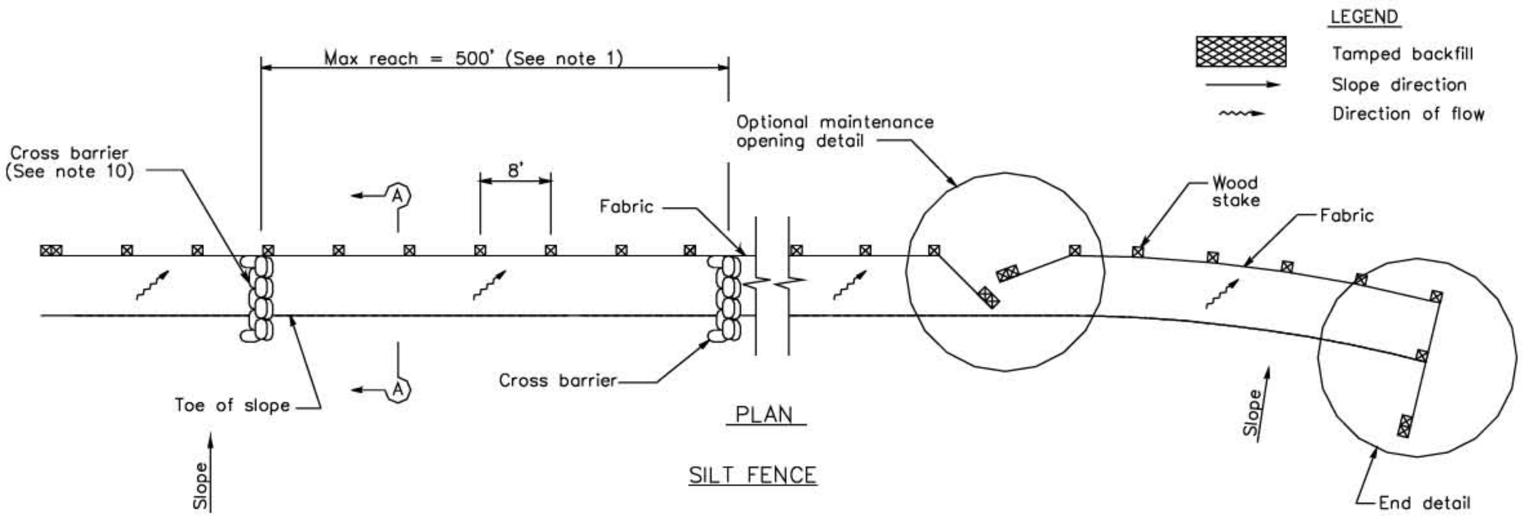
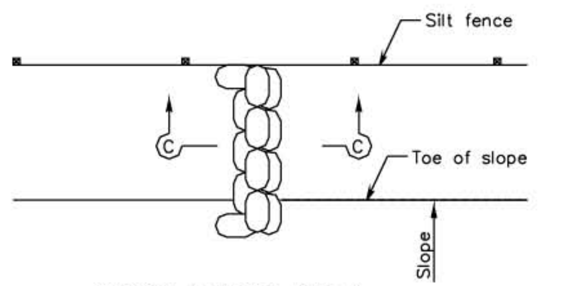


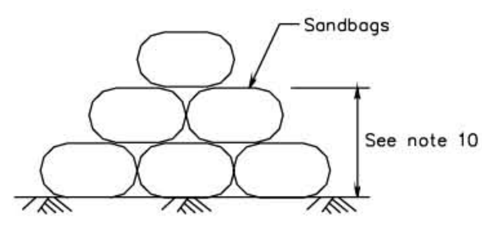
SILT FENCE

NOTES

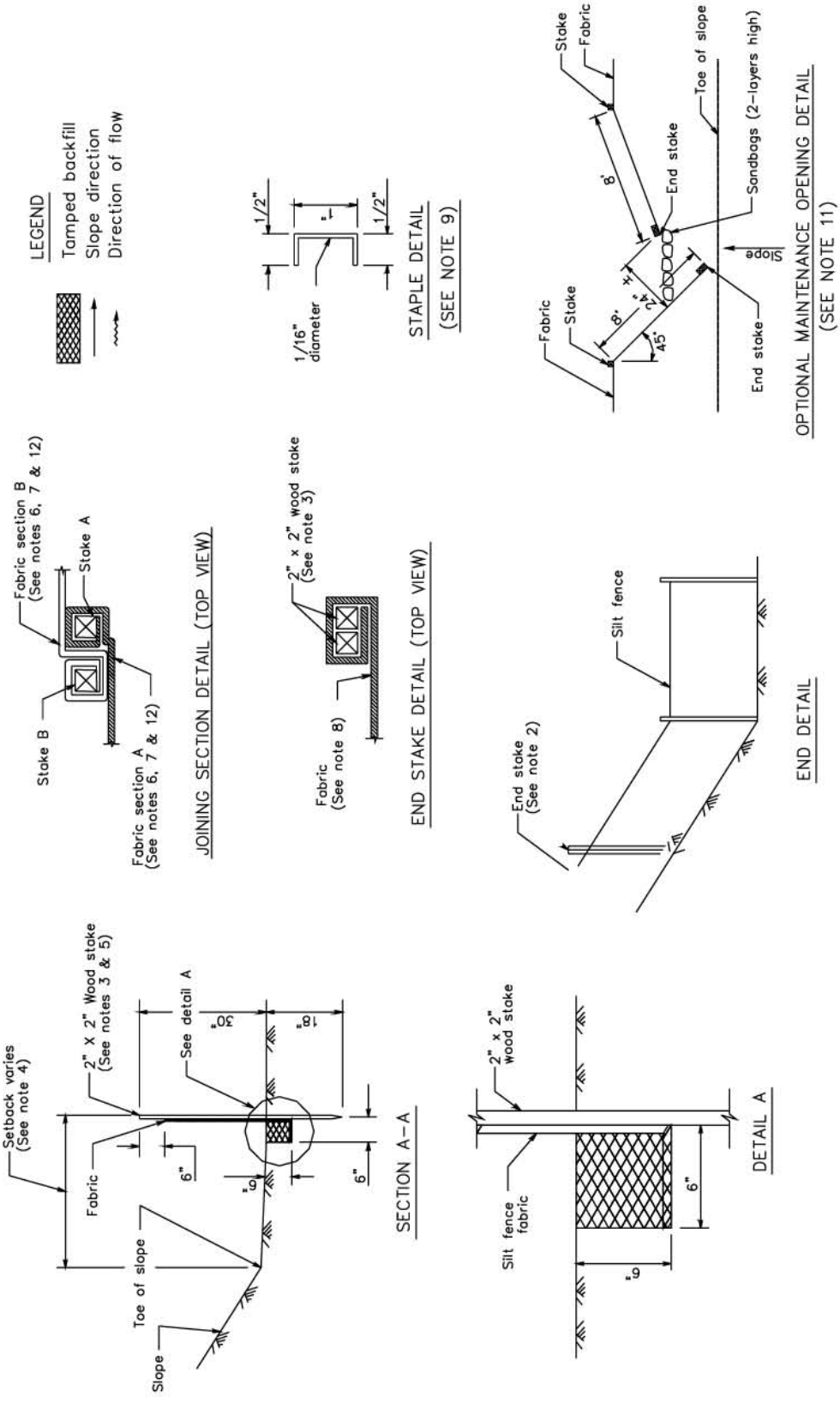
1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'-0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'-0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.



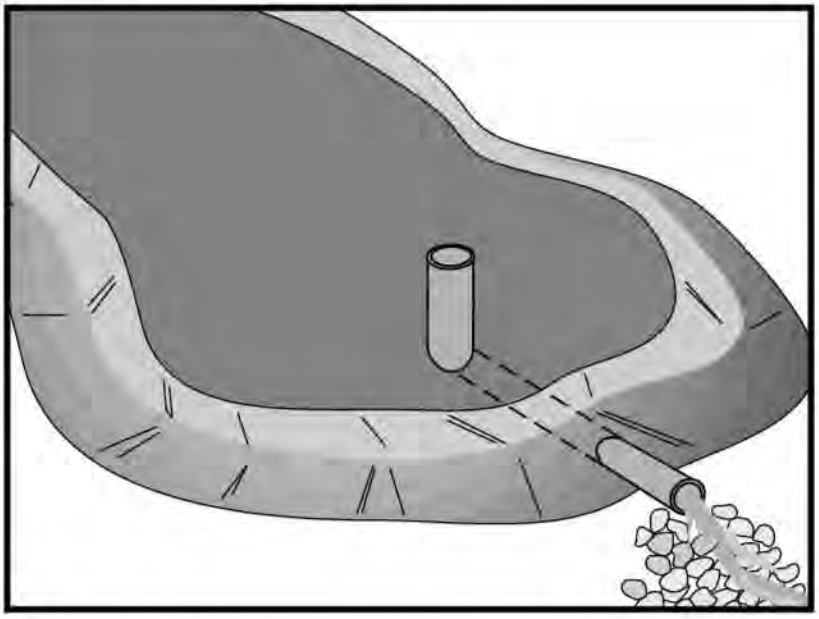
CROSS BARRIER DETAIL



SECTION C-C


LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
8'
End stake
Sandbags (2-layers high)
Slope
Fabric
Stake
8'
4'
2'
45°
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
18"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A-A
2" x 2"
wood stake
Silt fence
fabric
6"
6"
DETAIL A

Sediment Basin SE-2



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of

public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from Division of Safety of Dams.
- Standing water may cause mosquitoes or other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 % of the sediment that flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as

temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). The basin must not be located in a stream but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in a stream.
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and local dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

Sediment basins must be designed in accordance with Section A of the State of California NPDES General Permit for Stormwater Discharges Associated with Construction Activities (General Permit) where sediment basins are the only control measure proposed for the site. If there is insufficient area to construct a sediment basin in accordance with the General Permit requirements, then the alternate design standards specified herein may be used.

Sediment basins designed per the General Permit shall be designed as follows:

Option 1:

Pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 3.

OR

Option 2:

Sediment basin(s), as measured from the bottom of the basin to the principal outlet, shall have at least a capacity equivalent to 3,600 cubic feet (133 yd^3) of storage per acre draining into the sediment basin. The length of the basin shall be more than twice the width of the basin. The

length is determined by measuring the distance between the inlet and the outlet; and the depth must not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency.

OR

Option 3:
Sediment basin(s) shall be designed using the standard equation:

$$As=1.2Q/Vs \quad \text{(Eq. 1)}$$

Where:

As = Minimum surface area for trapping soil particles of a certain size

Vs = Settling velocity of the design particle size chosen

Q = C I A

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient

I = Precipitation intensity for the 10-year, 6-hour rain event

A = Area draining into the sediment basin in acres

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the *Vs* used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the 2 ft of capacity.

OR

Option 4:
The use of an equivalent surface area design or equation, provided that the design efficiency is as protective or more protective of water quality than Option 3.

Other design considerations are:

- The volume of the settling zone should be sized to capture runoff from a 2-year storm or other appropriate design storms specified by the local agency. A detention time of 24 to 40 hours should allow 70 to 80 % of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- Sediment basins are best used in conjunction with erosion controls. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed according to the four options required by the General Permit (see Options 1-4 above). Sediment basins that are used in conjunction with upstream erosion and sediment controls should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.
- The length of the basin should be more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet.
- The depth must be no less than 3 ft.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- Basins should be designed to drain within 72 hours following storm events. If a basin fails to drain within 72 hours, it must be pumped dry.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.

- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 72 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 72-hour limit is specified to mitigate vector control concerns.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets follow:
  - *Flow Control Using a Single Orifice At The Bottom Of The Basin (Figure 1)*: The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H-Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H-Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

where:

a = area of orifice (ft^2)

A = surface area of the basin at mid elevation (ft^2)

C = orifice coefficient

T = drawdown time of full basin (hrs)

g = gravity (32.2 ft/s²)

H = elevation when the basin is full (ft)

Ho = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H - Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

- *Flow Control Using Multiple Orifices (see Figure2):*

$$a_t = \frac{2A(h_{\max})}{3600CT(2g[h_{\max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

a_t = total area of orifices

h_{max} = maximum height from lowest orifice to the maximum water surface (ft)

$h_{centroid\ of\ orifices}$ = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

Average annual costs for installation and maintenance (2 year useful life) are:

- Basin less than 50,000 ft³: Range, $0.24 - $1.58/ft³. Average, $0.73 per ft³. $400 - $2,400, $1,200 average per drainage acre.
- Basin size greater than 50,000 ft³: Range, $0.12 – $0.48/ft³. Average, $0.36 per ft³. $200 - $800, $600 average per drainage acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at appropriate locations.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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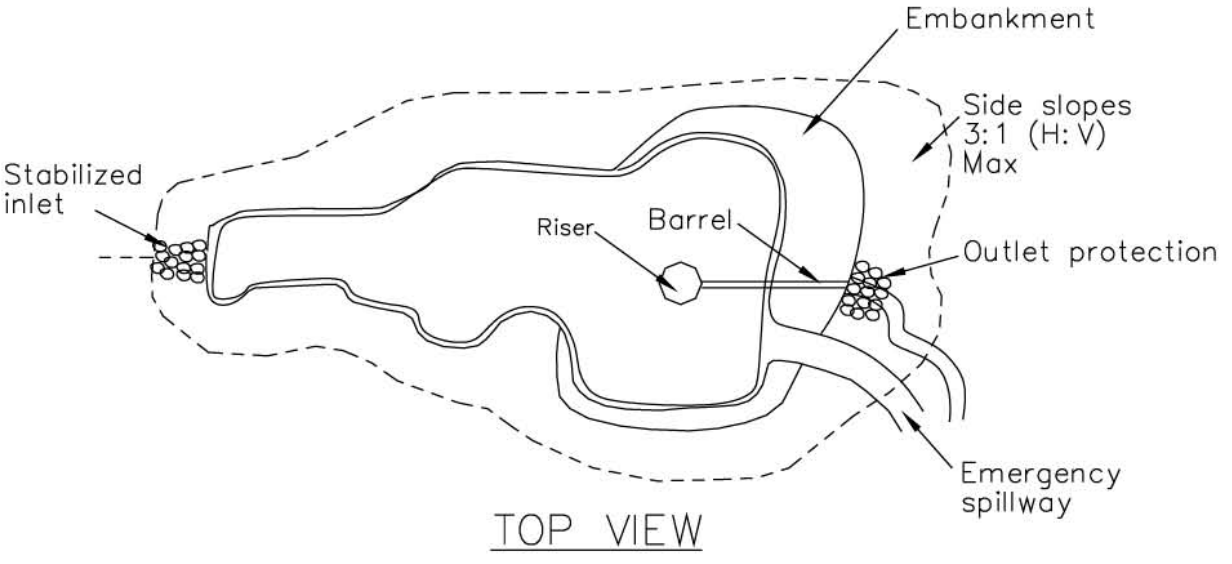
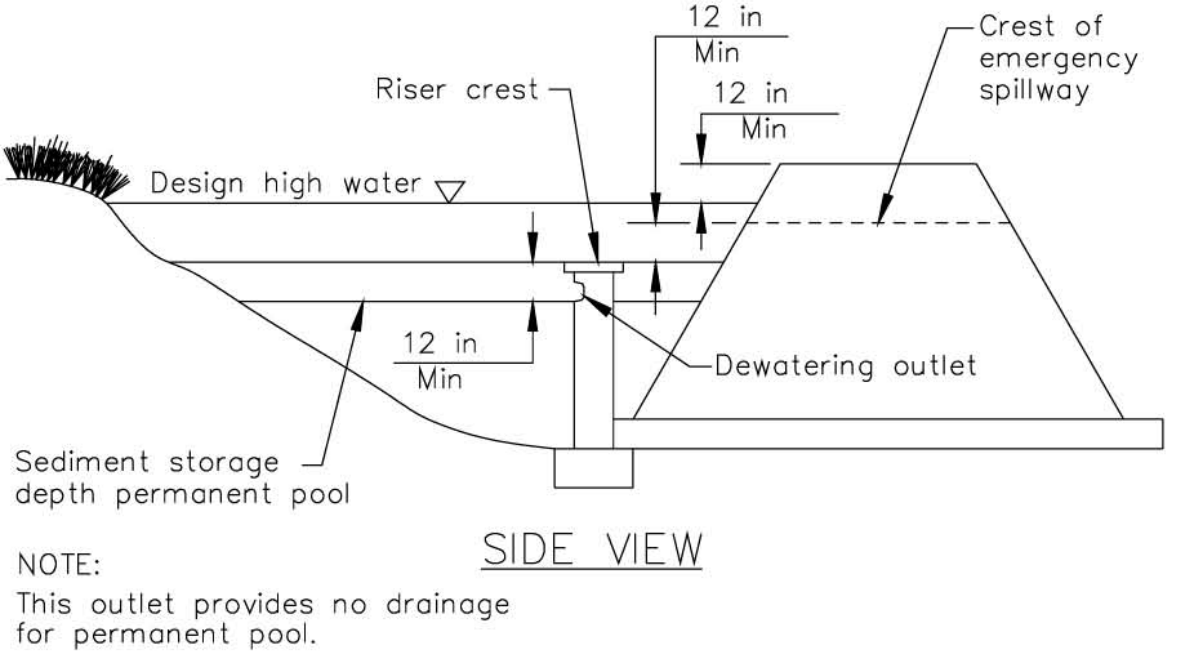




NOTE:
This outlet provides no drainage for permanent pool.

FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
SINGLE ORIFICE DESIGN
NOT TO SCALE

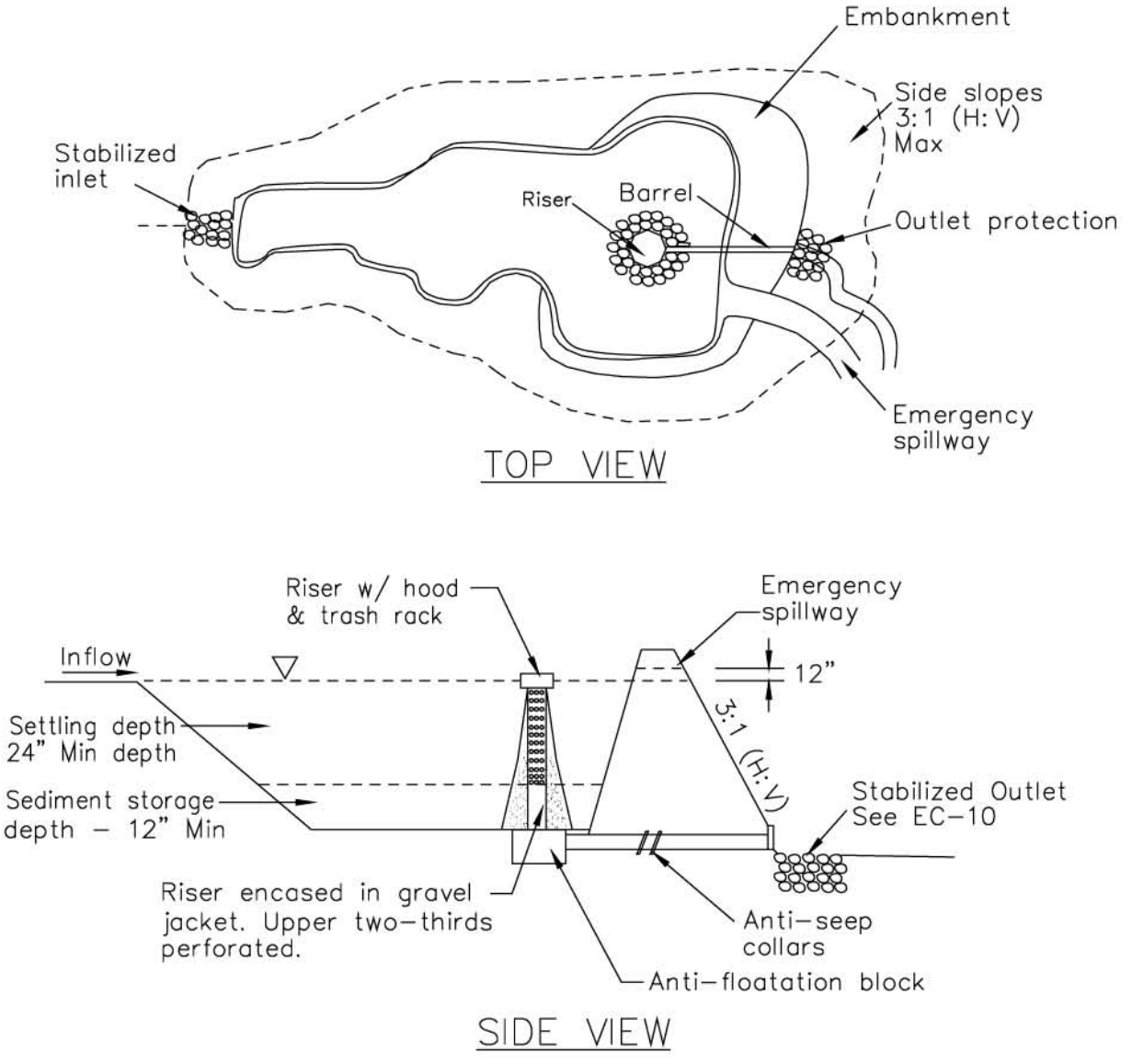


FIGURE 2: TYPICAL TEMPORARY SEDIMENT BASIN

MULTIPLE ORIFICE DESIGN

NOT TO SCALE

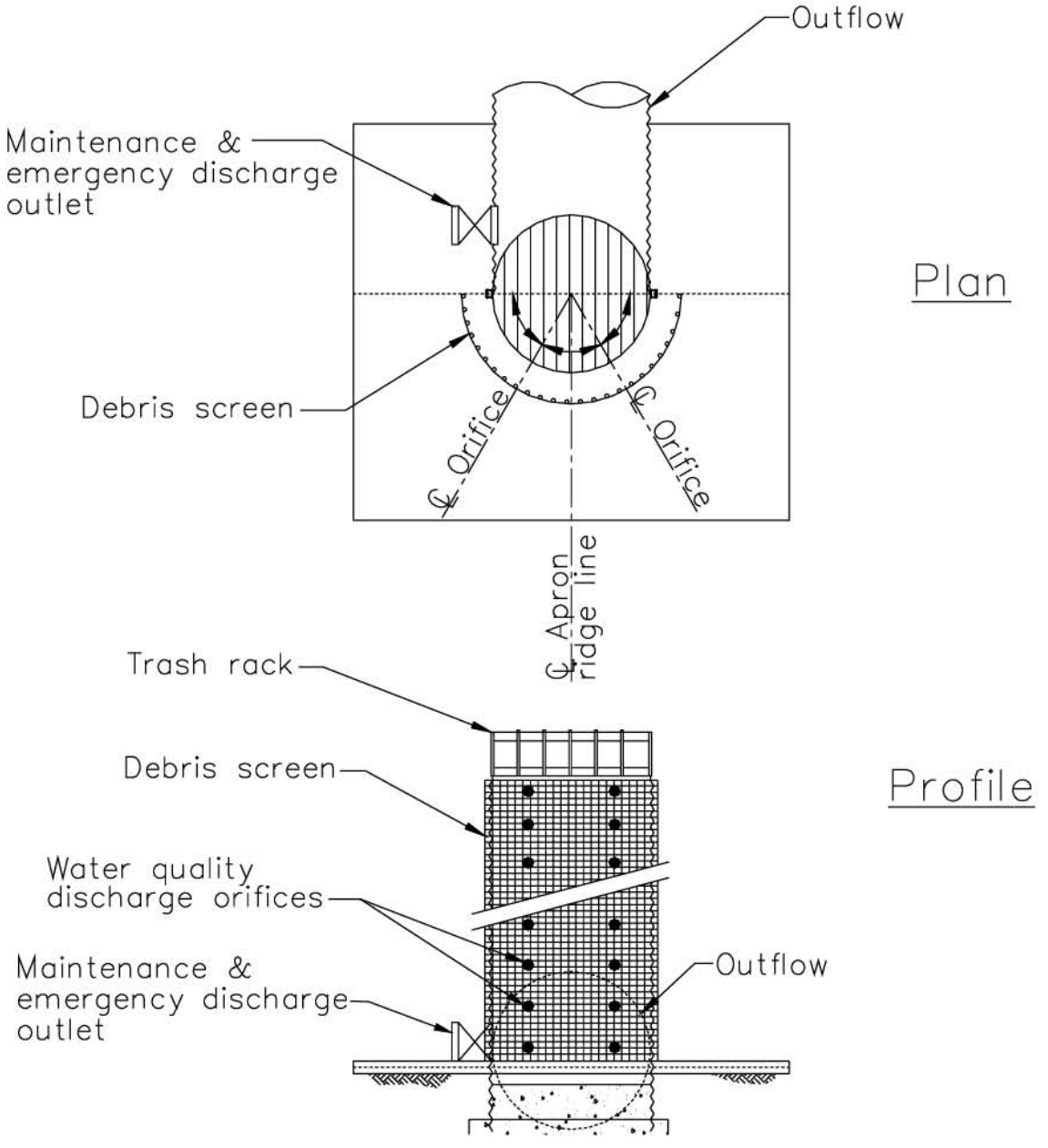
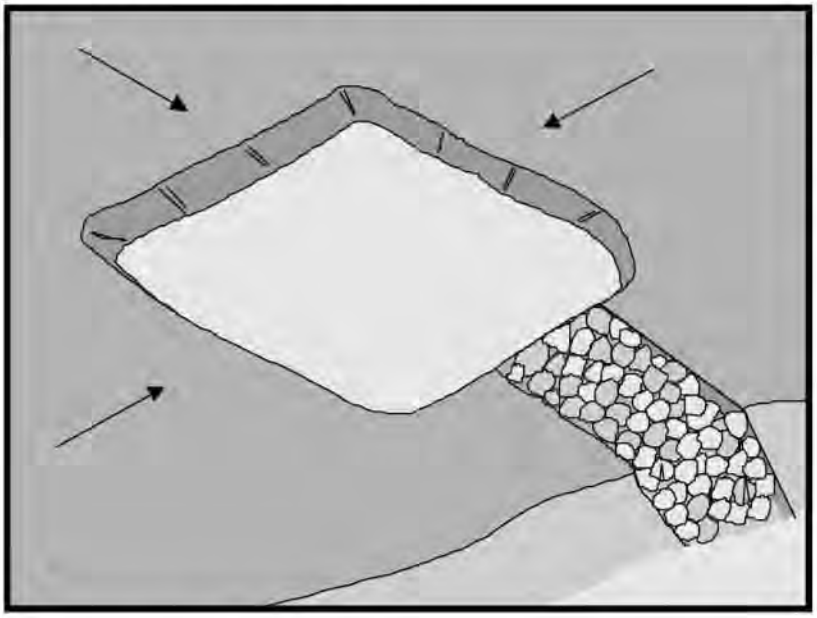


FIGURE 3: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

Sediment Trap SE-3



Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.
- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed of, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.
- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.
- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.

- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect outlet area for erosion and stabilize if required.
- Inspect trap banks for seepage and structural soundness, repair as needed.
- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Inspect fencing for damage and repair as needed.
- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 72 hours or less to prevent vector production.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.
- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.

References

Brown, W., and T. Schueler. The Economics of Stormwater BMPs in the Mid-Atlantic Region. Prepared for Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD, 1997.

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Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

U.S. Environmental Protection Agency (USEPA). Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters. EPA 840-B-9-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1993.

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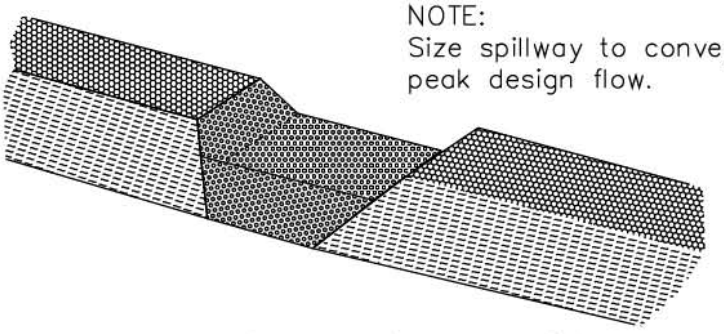
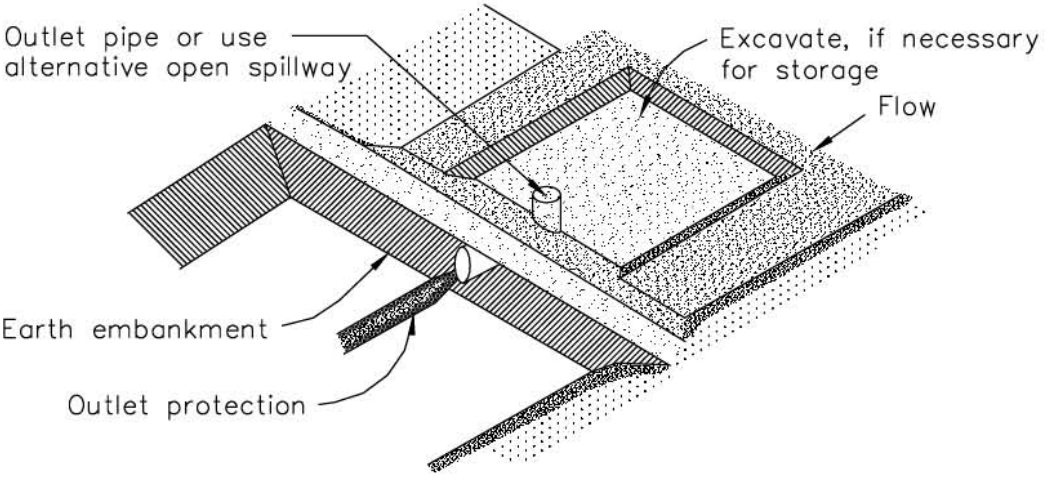
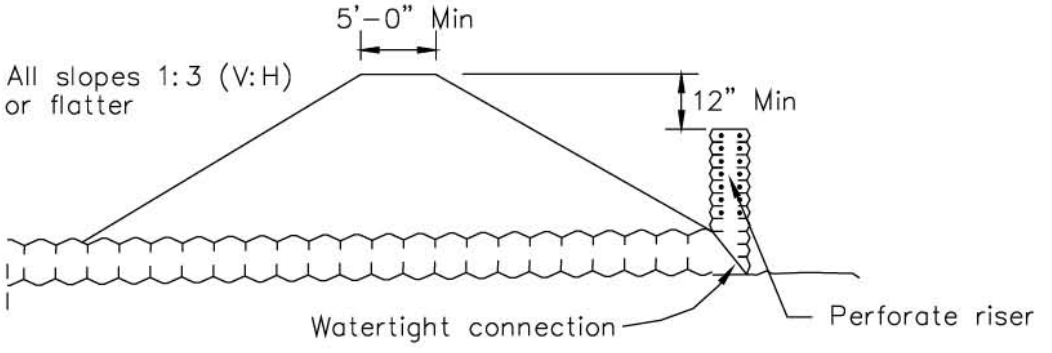


TYPICAL OPEN SPILLWAY

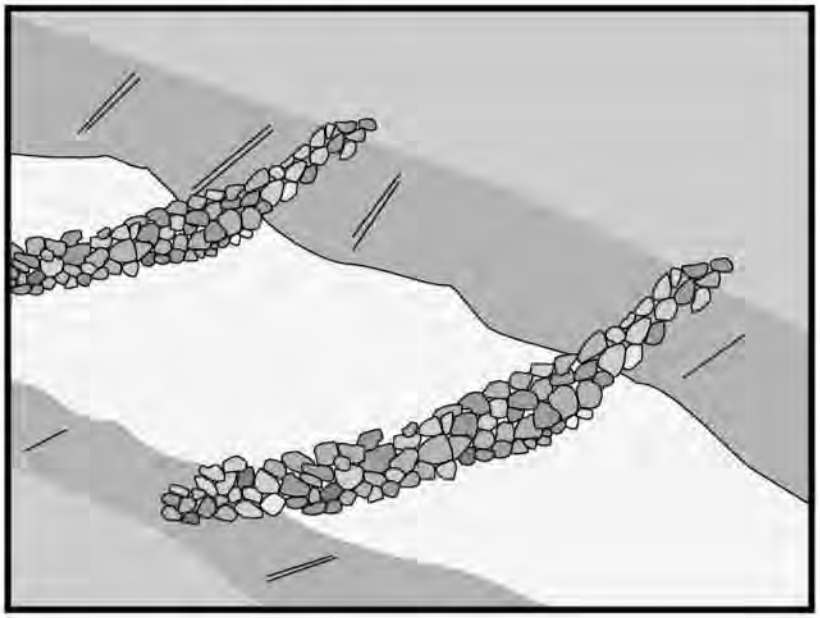




EMBANKMENT SECTION THRU RISER

TYPICAL SEDIMENT TRAP
NOT TO SCALE

Check Dams SE-4



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows.

- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity must be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Don't use check dams. Consider alternative BMPs.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Straw bales can also be used for check dams and can work if correctly installed; but in practice, straw bale check dams have a high failure rate. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch

or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- Backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap must be cleaned following each storm event.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.
- Gravel bags may be used as check dams with the following specifications:

Materials

Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms. Sandbags used for check dams should conform to SE-8, Sandbag Barrier. Fiber rolls used for check dams should conform to SE-5, Fiber Rolls. Straw bales used for check dams should conform to SE-9, Straw Bale Barrier.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section. Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls and straw bales must be trenched in and firmly staked in place.

Costs

Cost consists of only installation costs if materials are readily available. If material must be imported, costs may increase. For material costs, see SE-5, SE-6, SE-8 and SE-9.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

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Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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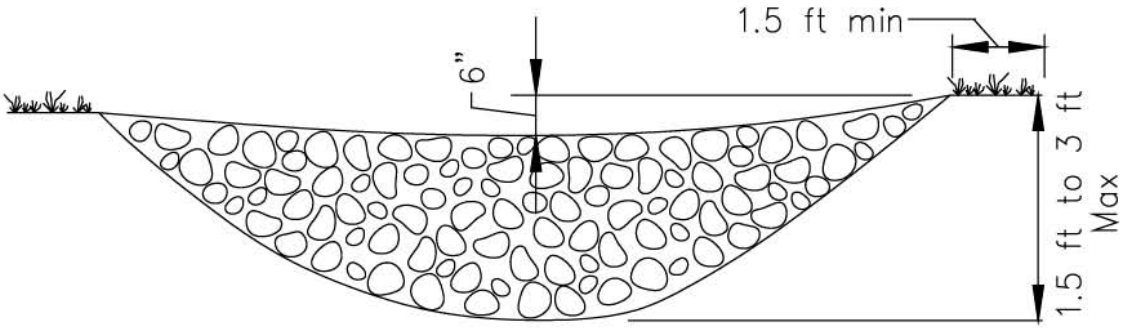
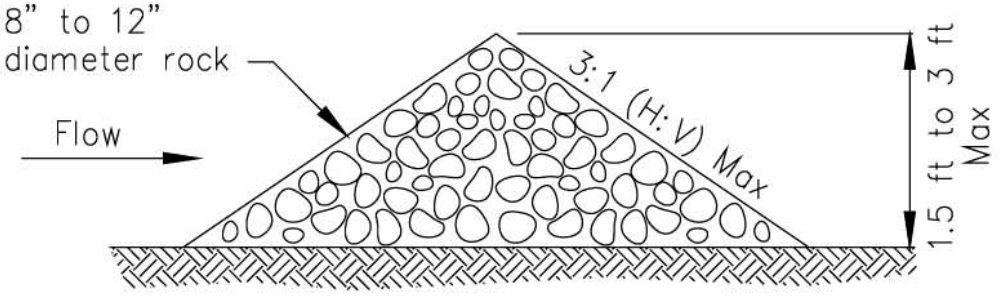
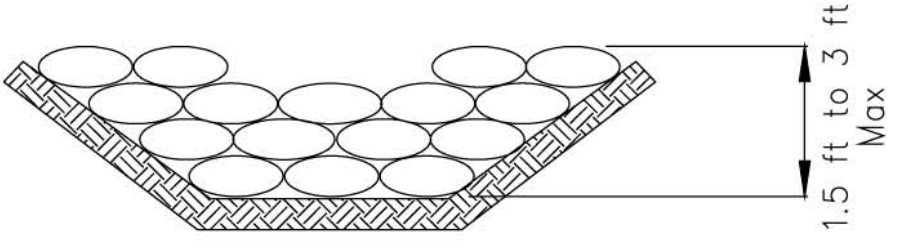


ELEVATION



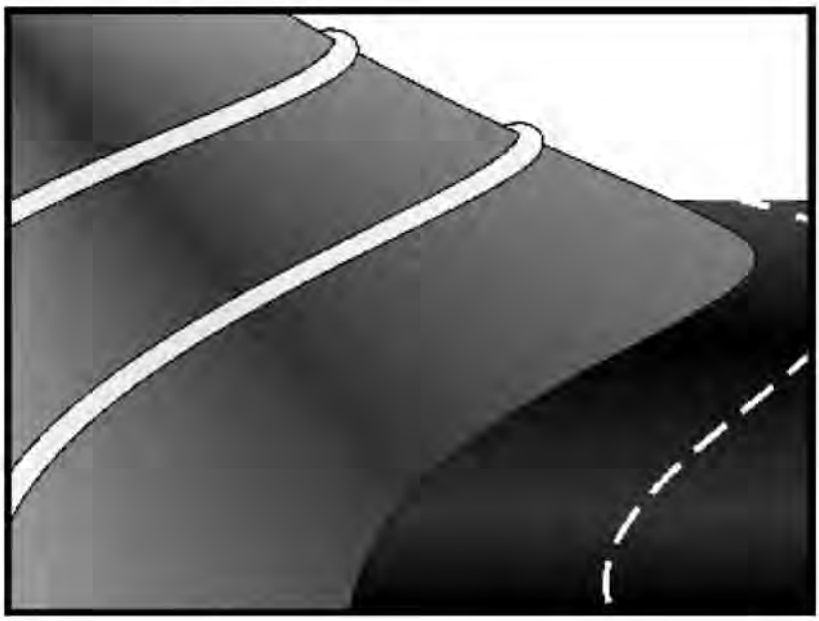
TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE

Fiber Rolls SE-5



Description and Purpose

A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles

Limitations

- Fiber rolls are not effective unless trenched

Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Implementation

Fiber Roll Materials

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft along length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.

- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Costs

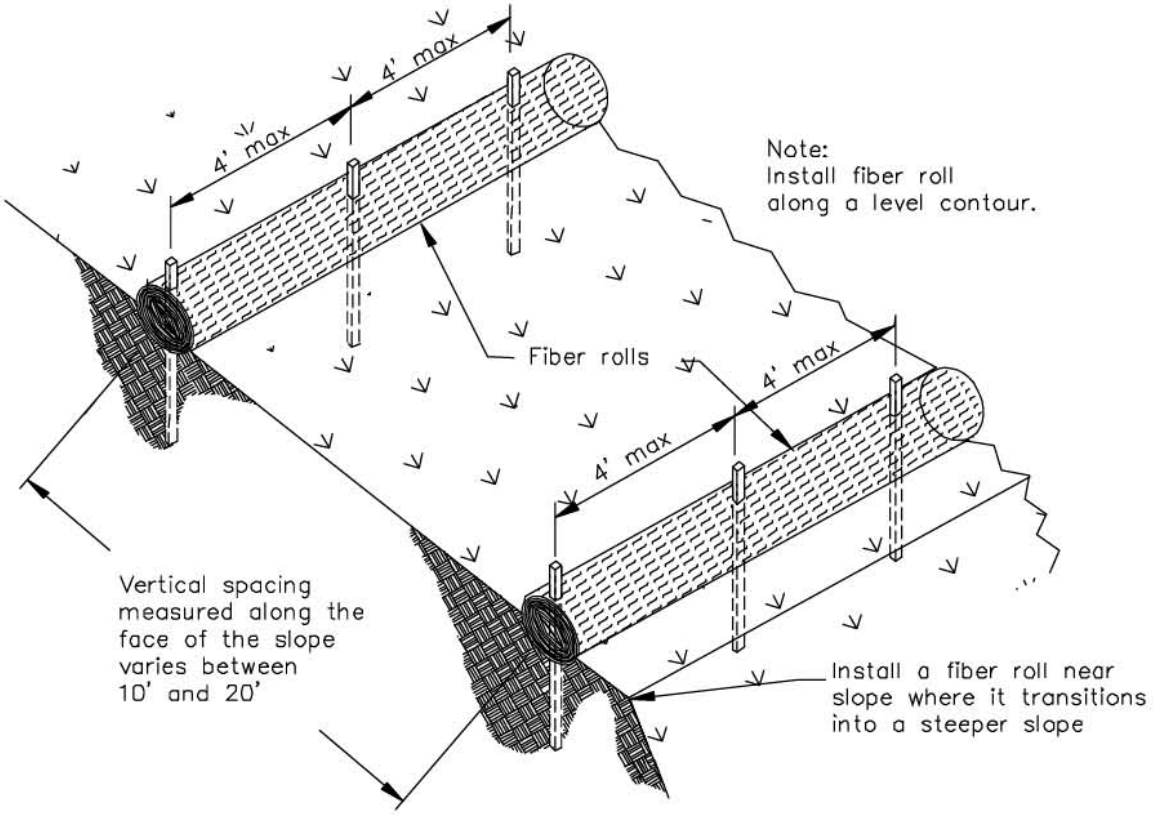
Material costs for fiber rolls range from $20 - $30 per 25 ft roll.

Inspection and Maintenance

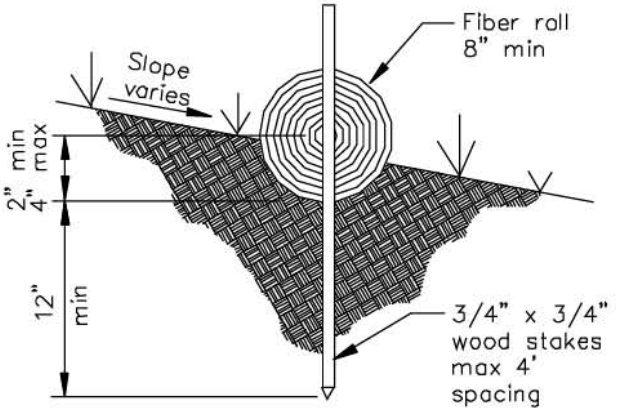
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site of disposed at an appropriate location.
- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

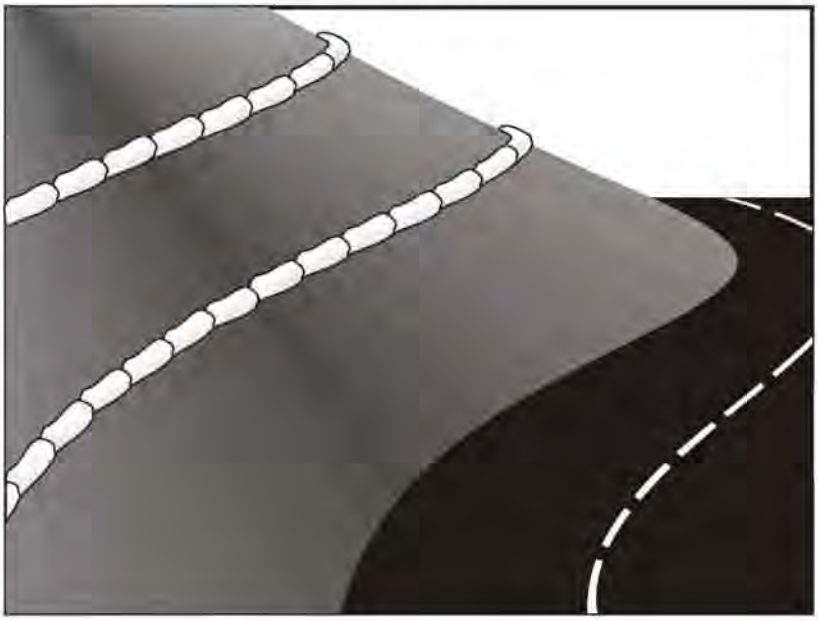


TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.

Gravel Bag Berm SE-6



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flows, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As linear erosion control measure:

- Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the top of slopes to divert runoff away from disturbed slopes
- As check dams across mildly sloped construction roads

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the filter, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Berms may have limited durability for long-term projects.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel–filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous.

Design and Layout

- Locate gravel bag berms on level contours.
  - Slopes between 20:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 50 ft (a closer spacing is more effective), with the first row near the slope toe.
  - Slopes 2:1 (H:V) or steeper: Gravel bags should be placed at a maximum interval of 25 ft (a closer spacing is more effective), with the first row placed the slope toe.
- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.

- For installation near the toe of the slope, consider moving the gravel bag barriers away from the slope toe to facilitate cleaning. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 or flatter.
- Butt ends of bags tightly
- On multiple row, or multiple layer construction, overlapp butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.
- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.
- ***Fill Material:*** Fill material should be 0.5 to 1 in. Class 2 aggregate base, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Gravel filter: Expensive, since off-site materials, hand construction, and demolition/removal are usually required. Material costs for gravel bags are average of $2.50 per empty gravel bag. Gravel costs range from $20-$35 per yd^3.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.
- Reshape or replace gravel bags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Remove gravel bag berms when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of.

References

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Street Sweeping and Vacuuming SE-7

Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.

- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from $58/hour (3 yd^3 hopper) to $88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

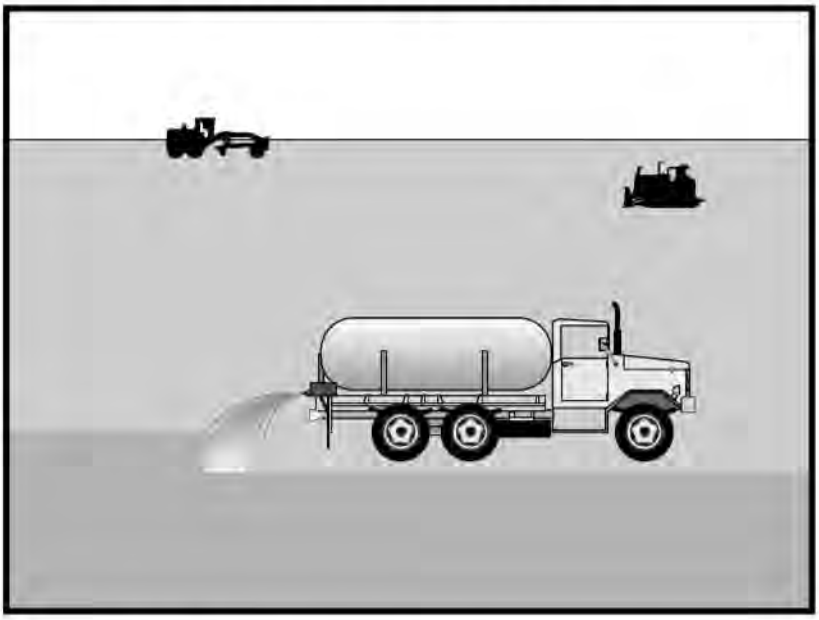
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Wind Erosion Control WE-1



Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

Suitable Applications

Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.

- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Effectiveness depends on soil, temperature, humidity, and wind velocity.
- Chemically treated sub grades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- Asphalt, as a mulch tack or chemical mulch, requires a 24-hour curing time to avoid adherence to equipment, worker shoes, etc. Application should be limited because asphalt surfacing may eventually migrate into the drainage system.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.

Implementation

General

California's Mediterranean climate, with short wet seasons and long hot dry seasons, allows the soils to thoroughly dry out. During these dry seasons, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment.

Dust control, as a BMP, is a practice that is already in place for many construction activities. Los Angeles, the North Coast, and Sacramento, among others, have enacted dust control ordinances for construction activities that cause dust to be transported beyond the construction project property line.

Recently, the State Air Resources Control Board has, under the authority of the Clean Air Act, started to address air quality in relation to inhalable particulate matter less than 10 microns (PM-10). Approximately 90 percent of these small particles are considered to be dust. Existing dust control regulations by local agencies, municipal departments, public works department, and public health departments are in place in some regions within California.

Many local agencies require dust control in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. The following are measures that local agencies may have already implemented as requirements for dust control from contractors:

- Construction and Grading Permits: Require provisions for dust control plans.
- Opacity Emission Limits: Enforce compliance with California air pollution control laws.
- Increase Overall Enforcement Activities: Priority given to cases involving citizen complaints.
- Maintain Field Application Records: Require records of dust control measures from contractor;
- Stormwater Pollution Prevention Plan: (SWPPP): Integrate dust control measures into SWPPP.

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table shows dust control practices that can be applied to site conditions that cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures would include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph, and controlling the number and activity of vehicles on a site at any given time.

SITE CONDITION	DUST CONTROL PRACTICES								
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Silt Fences	Temporary Gravel Construction Entrances/Equipment Wash Down	Haul Truck Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X				X
Disturbed Areas Subject to Traffic			X	X	X		X		X
Material Stock Pile Stabilization			X	X		X			X
Demolition			X				X	X	
Clearing/ Excavation			X	X		X			X
Truck Traffic on Unpaved Roads			X	X	X		X	X	
Mud/Dirt Carry Out					X		X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (EC-1, Scheduling).
- Quickly stabilize exposed soils using vegetation, mulching, spray-on adhesives, calcium chloride, sprinkling, and stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Direct most construction traffic to stabilized roadways within the project site.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.

- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality Control Board requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."
- Materials applied as temporary soil stabilizers and soil binders also generally provide wind erosion control benefits.
- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for wet suppression or chemical stabilization of exposed soils.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and vehicle wash down areas.
- Stabilize inactive construction sites using vegetation or chemical stabilization methods.
- Limit the amount of areas disturbed by clearing and earth moving operations by scheduling these activities in phases.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater.

Costs

Installation costs for water and chemical dust suppression are low, but annual costs may be quite high since these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Check areas protected to ensure coverage.
- Most dust control measures require frequent, often daily, or multiple times per day attention.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

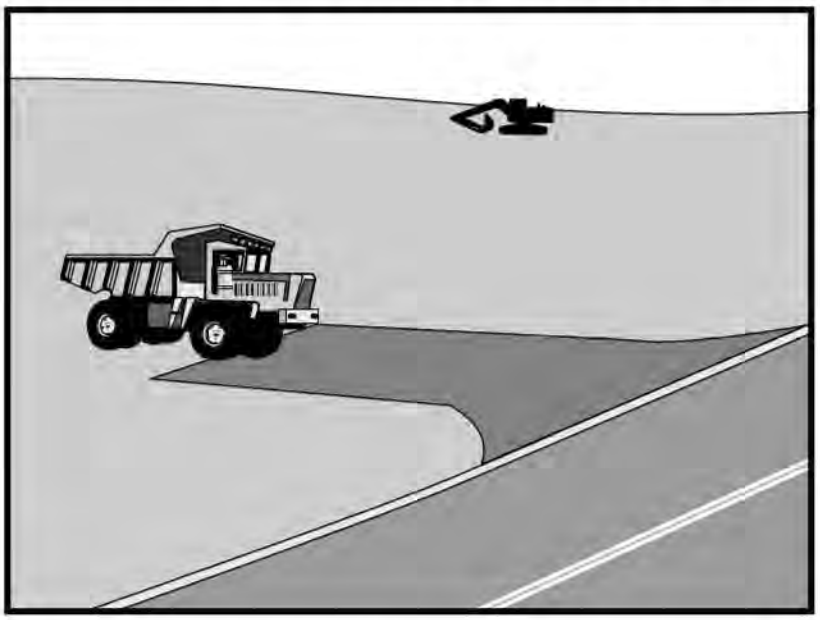
California Air Pollution Control Laws, California Air Resources Board, 1992.

Caltrans, Standard Specifications, Sections 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative".

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stabilized Construction Entrance/Exit TC-1



Objectives		
EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

Stabilized Construction Entrance/Exit TC-1

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

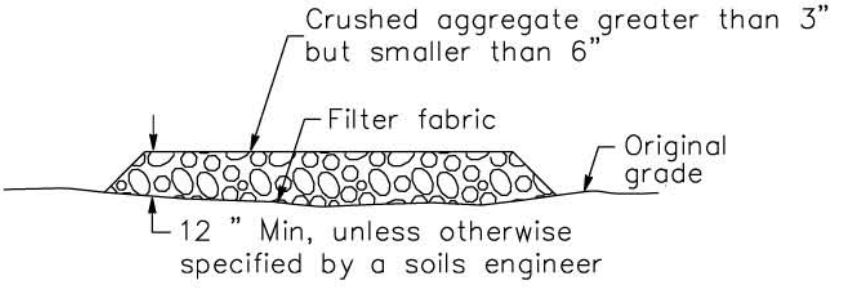
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

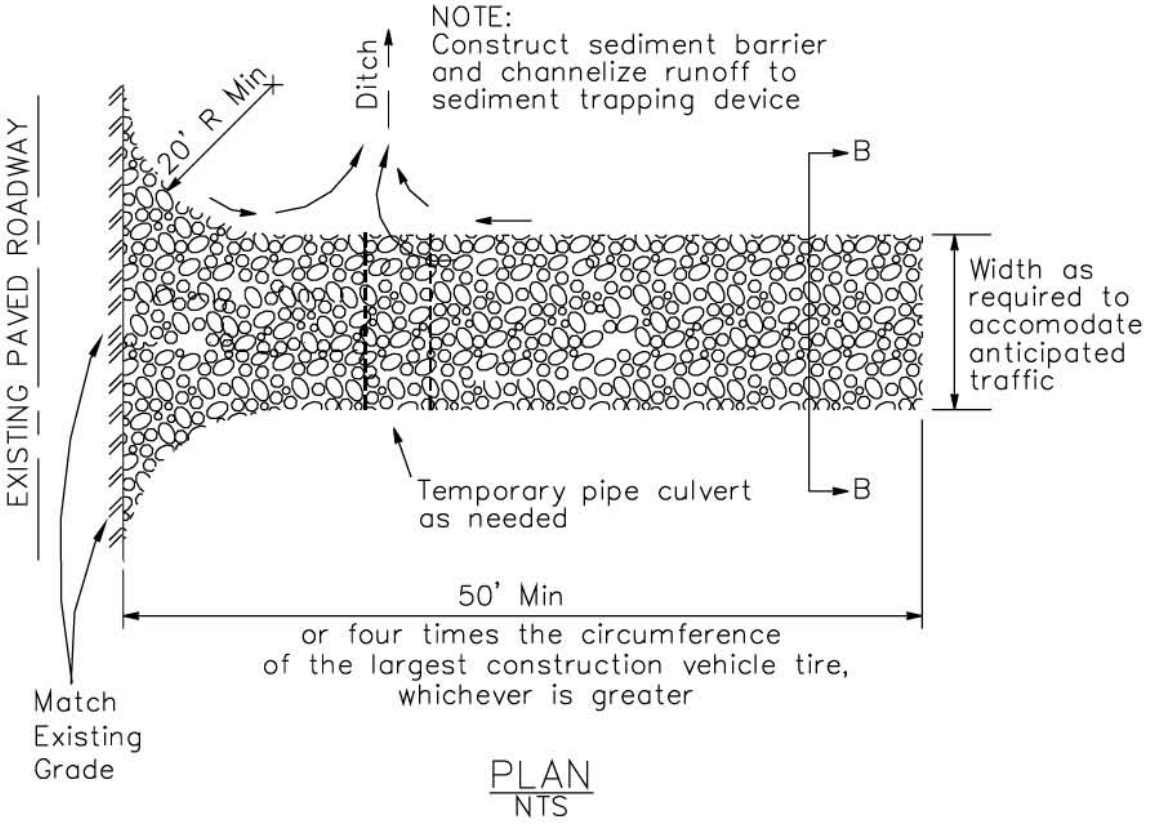
Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Stabilized Construction Entrance/Exit TC-1

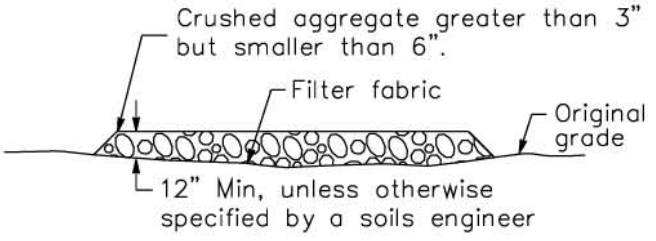


SECTION B–B
NTS



PLAN
NTS

Stabilized Construction Entrance/Exit TC-1



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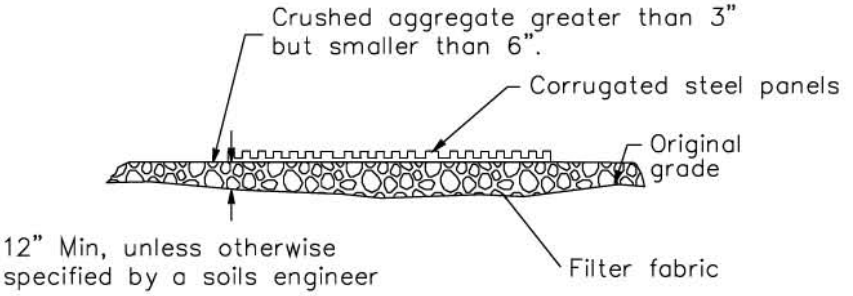
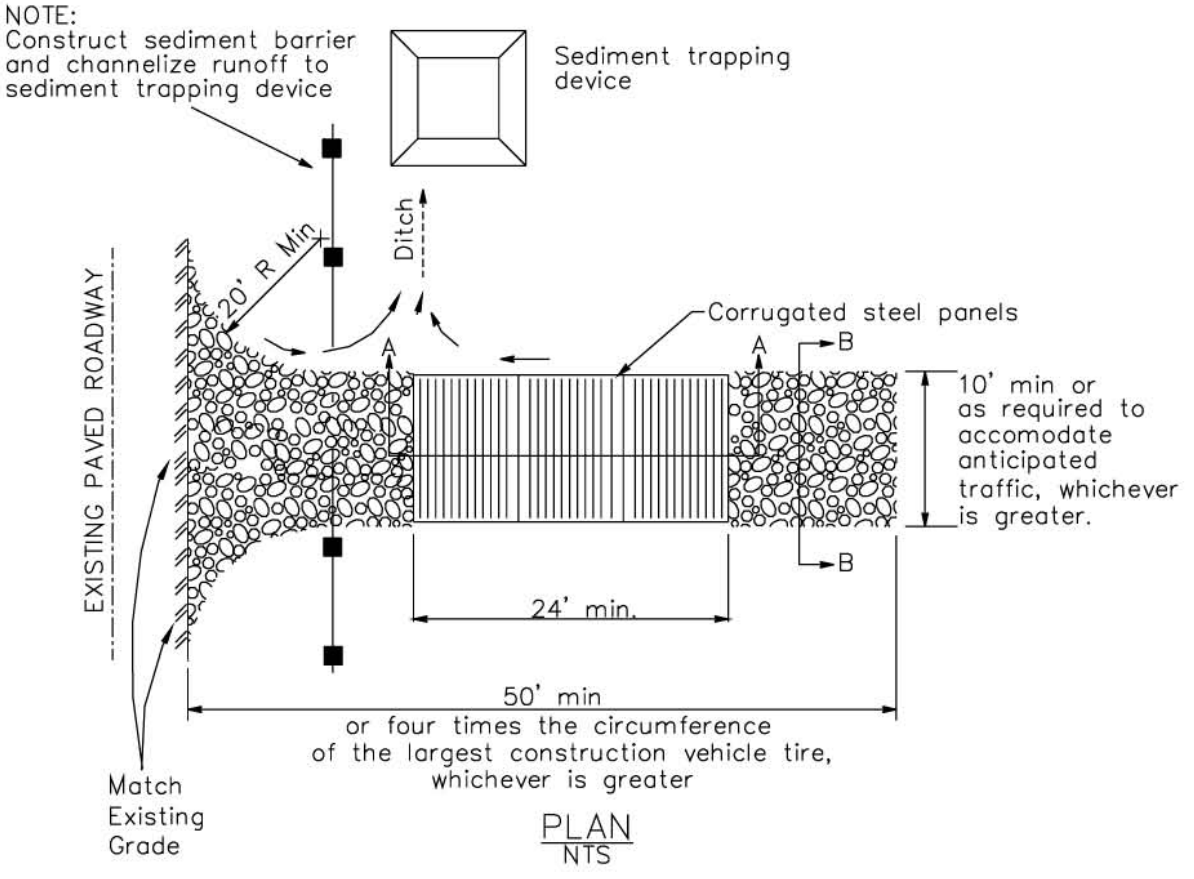


SECTION A–A
NOT TO SCALE



PLAN
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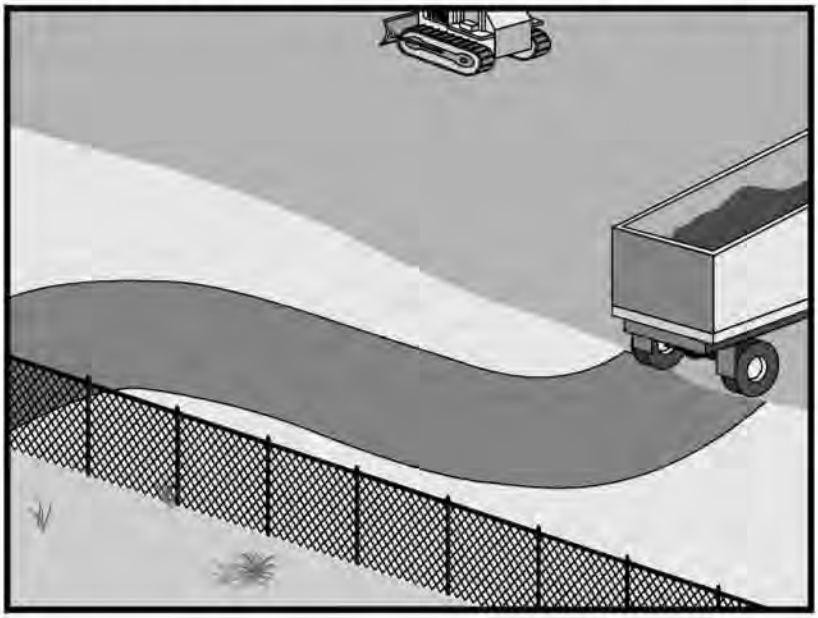
Stabilized Construction Roadway TC-2



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.

- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.
- Coordinate materials with those used for stabilized construction entrance/exit points.
- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, impact weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep all temporary roadway ditches clear.
- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.
- Periodically apply additional aggregate on gravel roads.
- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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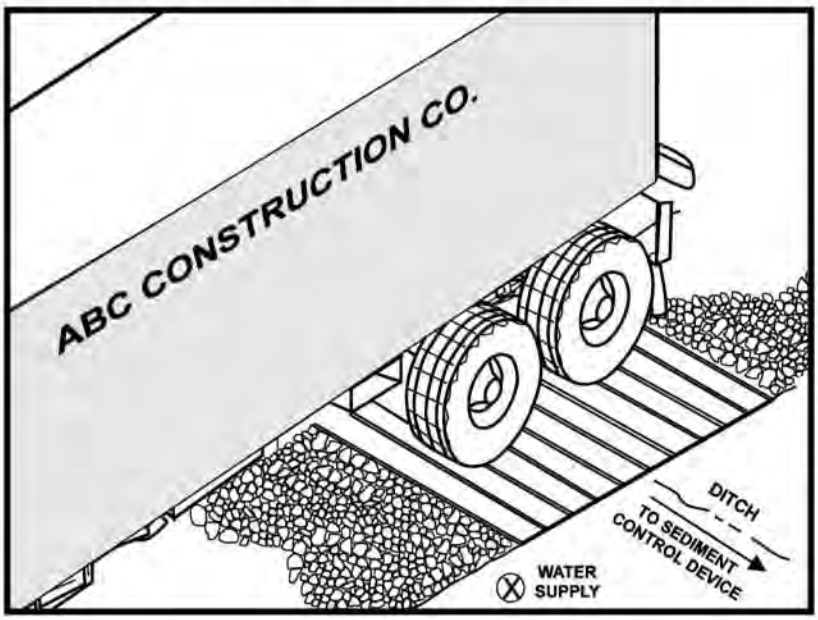
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Entrance/Outlet Tire Wash TC-3



Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TC-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement SC-7, Street Sweeping and Vacuuming, as needed.

Costs

Costs are low for installation of wash rack.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

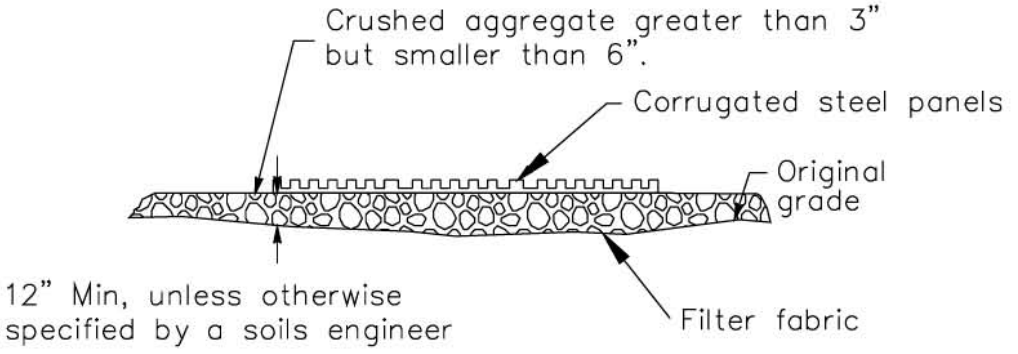
Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

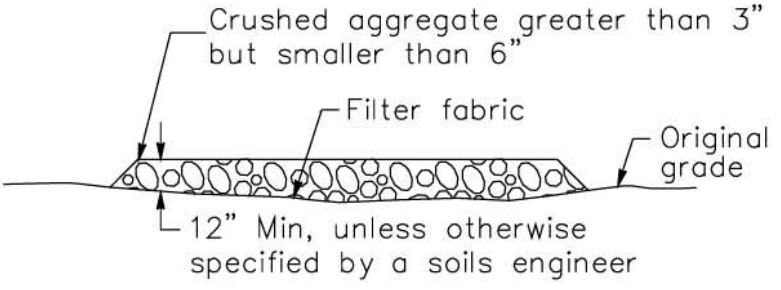
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

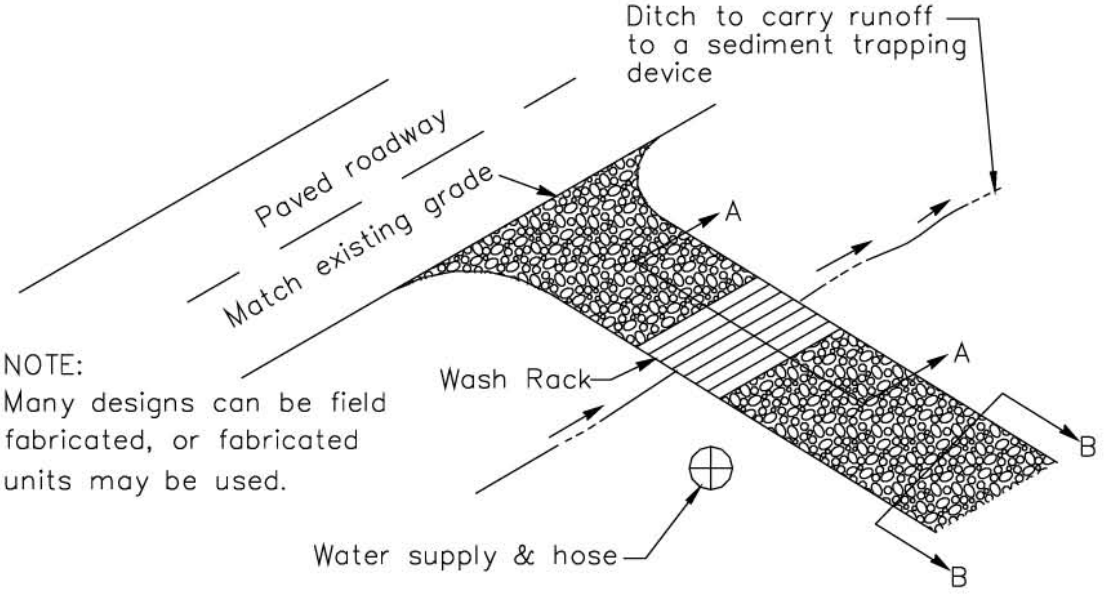
Entrance/Outlet Tire Wash TC-3



SECTION A–A
NOT TO SCALE



SECTION B–B
NTS



TYPICAL TIRE WASH
NOT TO SCALE

Water Conservation Practices NS-1

Objectives		
EC	Erosion Control	☒
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ Primary Objective
☒ Secondary Objective

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.

- Direct construction water runoff to areas where it can soak into the ground or be collected and reused.
- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Dewatering Operations NS-2

Objectives		
EC	Erosion Control	
SE	Sediment Control	☒
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-stormwater and accumulated precipitation must be removed from a work location so that construction work may be accomplished.

Suitable Applications

These practices are implemented for discharges of non-stormwater from construction sites. Non-stormwaters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.

Limitations

- Site conditions will dictate design and use of dewatering operations.
- The controls discussed in this best management practice (BMP) address sediment only.
- The controls detailed in this BMP only allow for minimal settling time for sediment particles. Use only when site conditions restrict the use of the other control methods.
- Dewatering operations will require, and must comply with, applicable local permits.

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

SE-5: Fiber Roll

SE-6: Gravel Bag Berm

SE-9: Straw Bale Barrier

- Avoid dewatering discharges where possible by using the water for dust control, by infiltration, etc.

Implementation

- Dewatering non-stormwater cannot be discharged without prior notice to and approval from the Regional Water Quality Control Board (RWQCB) and local stormwater management agency. This includes stormwater that is co-mingled with groundwater or other non-stormwater sources. Once the discharge is allowed, appropriate BMPs must be implemented to ensure the discharge complies with all permit requirements and regional and watershed-specific requirements.
- RWQCB may require a separate NPDES permit prior to the dewatering discharge of non-stormwater. These permits will have specific testing, monitoring, and discharge requirements and can take significant time to obtain.
- The flow chart shown in Figure 1 should be utilized to guide dewatering operations.
- The owner will coordinate monitoring and permit compliance.
- Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.
- Dewatering discharges must not cause erosion at the discharge point.

A variety of methods can be used to treat water during dewatering operations. Several devices are presented below and provide options to achieve sediment removal. The size of particles present in the sediment and Permit or receiving water limitations on sediment are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate.

Sediment Basin (see also SE-2)

Description:

- A sediment basin is a temporary basin with a controlled release structure that is formed by excavation or construction of an embankment to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment basins are generally larger than Sediment Traps (SE-3).

Appropriate Applications:

- Effective for the removal of gravel, sand, silt, some metals that settle out with the sediment, and trash.

Implementation:

- Excavation and construction of related facilities is required.
- Temporary sediment basins must be fenced if safety is a concern.
- Outlet protection is required to prevent erosion at the outfall location.

Maintenance:

- Maintenance is required for safety fencing, vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-half.

Sediment Trap (See also SE-3)

Description:

- A sediment trap is a temporary basin formed by excavation and/or construction of an earthen embankment across a waterway or low drainage area to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment traps are generally smaller than Sediment Basins (SE-2).

Appropriate Applications:

Effective for the removal of large and medium sized particles (sand and gravel) and some metals that settle out with the sediment.

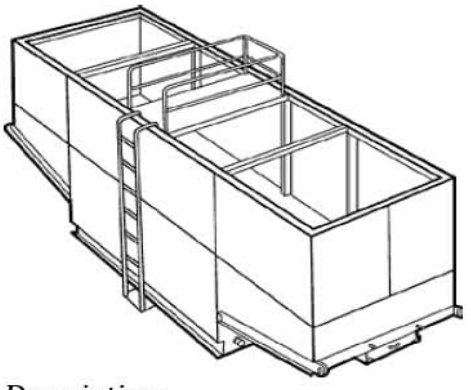
Implementation:

- Excavation and construction of related facilities is required.
- Trap inlets should be located to maximize the travel distance to the trap outlet.
- Use rock or vegetation to protect the trap outlets against erosion.

Maintenance:

- Maintenance is required for vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Weir Tanks



Description:

- A weir tank separates water and waste by using weirs. The configuration of the weirs (over and under weirs) maximizes the residence time in the tank and determines the waste to be removed from the water, such as oil, grease, and sediments.

Appropriate Applications:

- The tank removes trash, some settleable solids (gravel, sand, and silt), some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by licensed waste disposal company.

Dewatering Tanks

Description:

- A dewatering tank removes debris and sediment. Flow enters the tank through the top, passes through a fabric filter, and is discharged through the bottom of the tank. The filter separates the solids from the liquids.

Appropriate Applications:

- The tank removes trash, gravel, sand, and silt, some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

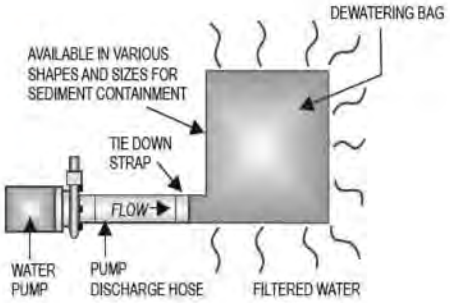
Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Oil and grease disposal must be by licensed waste disposal company.

Gravity Bag Filter



Description:

- A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects sand, silt, and fines.

Appropriate Applications:

- Effective for the removal of sediments (gravel, sand, and silt). Some metals are removed with the sediment.

Implementation:

- Water is pumped into one side of the bag and seeps through the bottom and sides of the bag.
- A secondary barrier, such as a rock filter bed or straw/hay bale barrier, is placed beneath and beyond the edges of the bag to capture sediments that escape the bag.

Maintenance:

- Inspection of the flow conditions, bag condition, bag capacity, and the secondary barrier is required.
- Replace the bag when it no longer filters sediment or passes water at a reasonable rate.
- The bag is disposed of offsite.

Sand Media Particulate Filter

Description:

- Water is treated by passing it through canisters filled with sand media. Generally, sand filters provide a final level of treatment. They are often used as a secondary or higher level of treatment after a significant amount of sediment and other pollutants have been removed using other methods.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, and silt and some metals, as well as the reduction of biochemical oxygen demand (BOD) and turbidity.
- Sand filters can be used for stand-alone treatment or in conjunction with bag and cartridge filtration if further treatment is required.
- Sand filters can also be used to provide additional treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filters require regular service to monitor and maintain the level of the sand media. If subjected to high loading rates, filters can plug quickly.
- Venders generally provide data on maximum head loss through the filter. The filter should be monitored daily while in use, and cleaned when head loss reaches target levels.
- If cleaned by backwashing, the backwash water may need to be hauled away for disposal, or returned to the upper end of the treatment train for another pass through the series of dewatering BMPs.

Pressurized Bag Filter

Description:

- A pressurized bag filter is a unit composed of single filter bags made from polyester felt material. The water filters through the unit and is discharged through a header. Vendors provide bag filters in a variety of configurations. Some units include a combination of bag filters and cartridge filters for enhanced contaminant removal.

Appropriate Applications:

- Effective for the removal of sediment (sand and silt) and some metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Oil absorbent bags are available for hydrocarbon removal.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.

Maintenance:

- The filter bags require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Cartridge Filter

Description:

- Cartridge filters provide a high degree of pollutant removal by utilizing a number of individual cartridges as part of a larger filtering unit. They are often used as a secondary or higher (polishing) level of treatment after a significant amount of sediment and other pollutants are removed. Units come with various cartridge configurations (for use in series with bag filters) or with a larger single cartridge filtration unit (with multiple filters within).

Appropriate Applications:

- Effective for the removal of sediment (sand, silt, and some clays) and metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Hydrocarbons can effectively be removed with special resin cartridges.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance.

Maintenance:

- The cartridges require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Costs

- Sediment controls are low to high cost measures depending on the dewatering system that is selected. Pressurized filters tend to be more expensive than gravity settling, but are often more effective. Simple tanks are generally rented on a long-term basis (one or more months) and can range from $360 per month for a 1,000 gallon tank to $2,660 per month for a 10,000 gallon tank. Mobilization and demobilization costs vary considerably.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Unit-specific maintenance requirements are included with the description of each unit.
- Sediment removed during the maintenance of a dewatering device may be either spread onsite and stabilized, or disposed of at a disposal site as approved by the owner.
- Sediment that is commingled with other pollutants must be disposed of in accordance with all applicable laws and regulations and as approved by the owner.

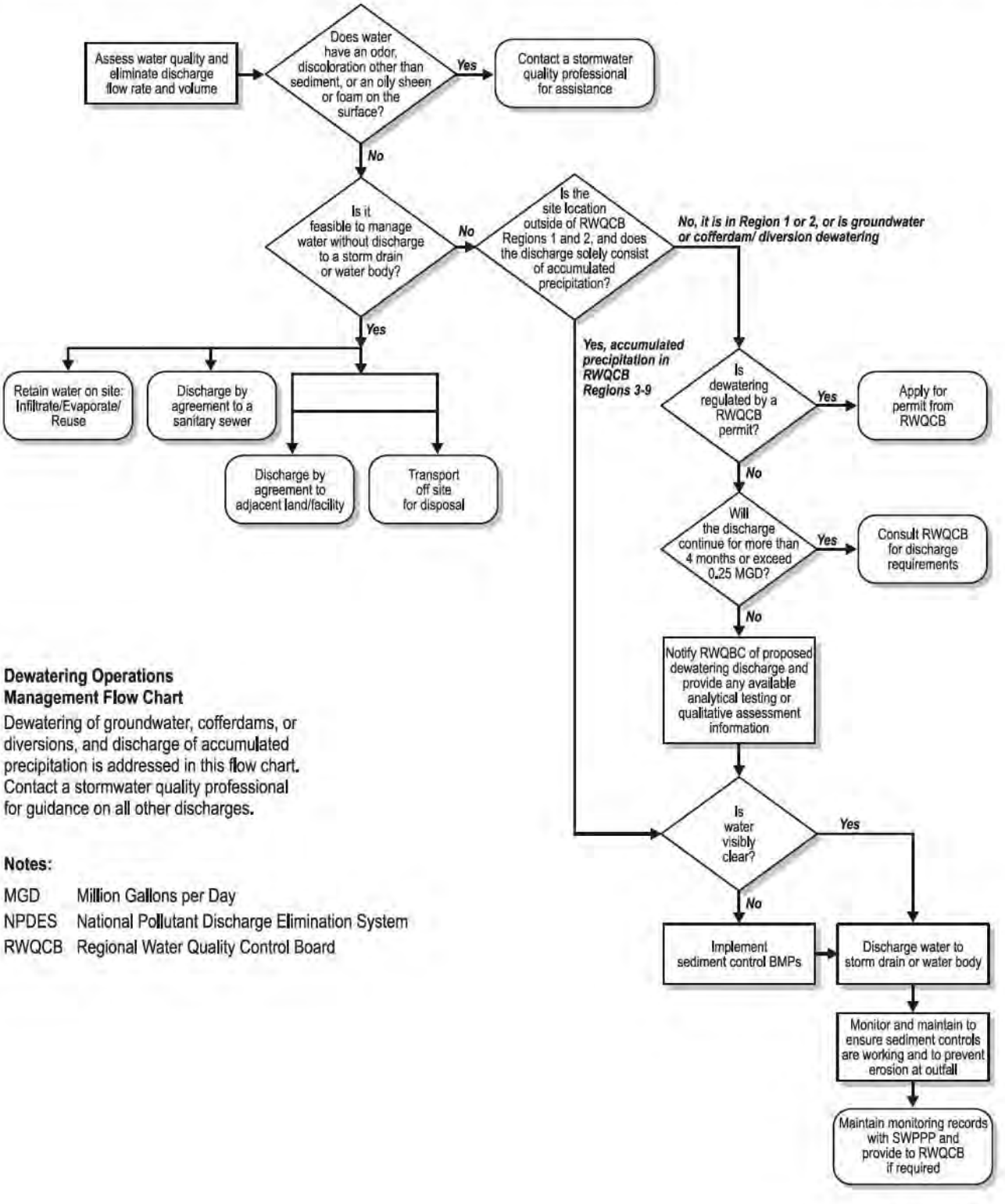
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Labor Surcharge & Equipment Rental Rates, April 1, 2002 through March 31, 2003, California Department of Transportation (Caltrans).



Dewatering Operations Management Flow Chart

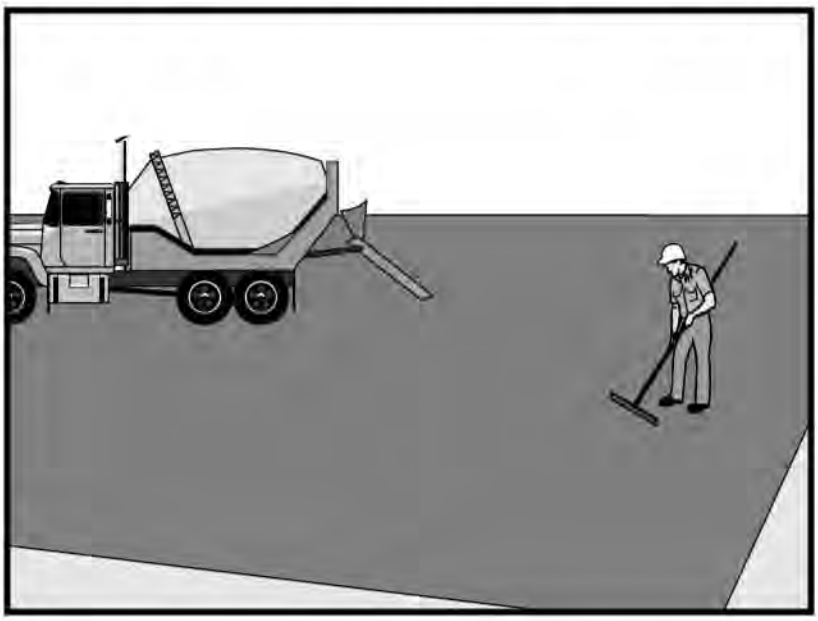
Dewatering of groundwater, cofferdams, or diversions, and discharge of accumulated precipitation is addressed in this flow chart. Contact a stormwater quality professional for guidance on all other discharges.

Notes:

MGD Million Gallons per Day
NPDES National Pollutant Discharge Elimination System
RWQCB Regional Water Quality Control Board

Figure 1
Operations Flow Chart

Paving and Grinding Operations NS-3



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☒

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Finer solids are not effectively removed by filtration systems.
- Paving opportunities may be limited during wet weather.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is in the forecast.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).

- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- If paving involves an onsite mixing plant, follow the stormwater permitting requirements for industrial activities.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses, These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC and AC waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing must not be allowed to enter any storm drains or watercourses. Install silt fence until structure is stabilized or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-9, Earth Dikes and Drainage Swales; SE-1, Silt Fence; or SE-5, Fiber Rolls.
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt must be recycled or disposed.
  - Any AC chunks and pieces used in embankments must be placed above the water table and covered by at least 1 ft of material.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine, should not be allowed to flow across the pavement, and should not be left on the surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.
- Dig out activities should not be conducted in the rain.
- Collect dig out material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.
- If dig out material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:

- Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management.

- Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect and return to aggregate base stockpile or dispose of properly.

- Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if allowed by the local wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate must not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized.

- Drainage inlet structures and manholes should be covered with filter fabric during application of seal coat, tack coat, slurry seal, and fog seal.

- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.

- Substances used to coat asphalt transport trucks, and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.

- Use only non-toxic substances to coat asphalt transport trucks and asphalt spreading equipment.

- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.

- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the stormwater drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move when the vehicle is deadheaded.
- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the stormwater drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing when vehicle is deadheaded.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

Costs

- All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

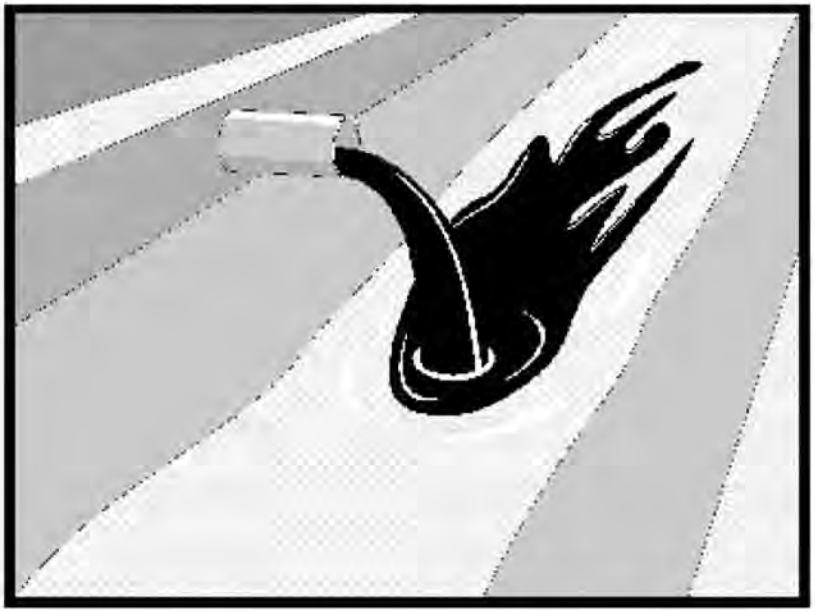
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Illicit Connection/Discharge NS-6



Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.

Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

- Inspect site regularly during project execution for evidence of illicit connections, illegal dumping or discharges.
- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General –** unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** - Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** - signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas** - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas** - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

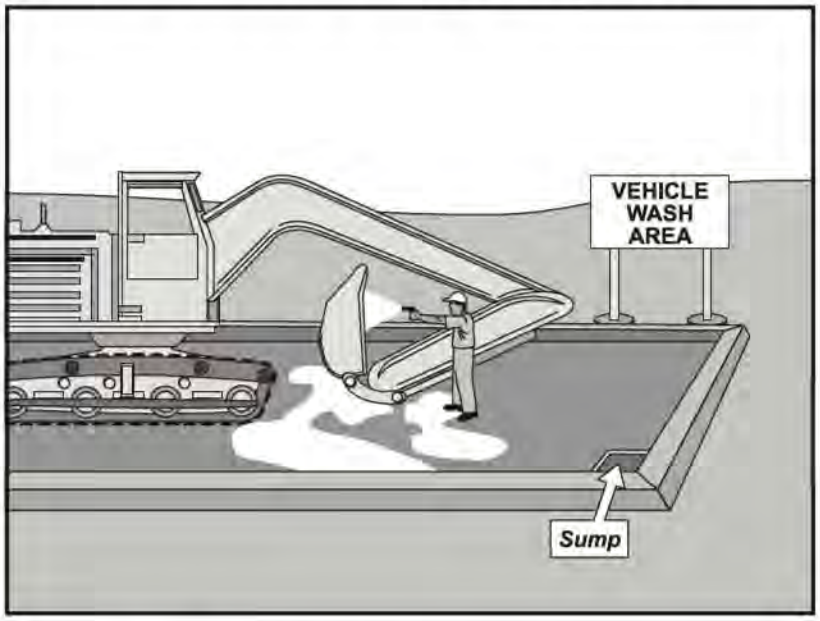
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle and Equipment Cleaning NS-8



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

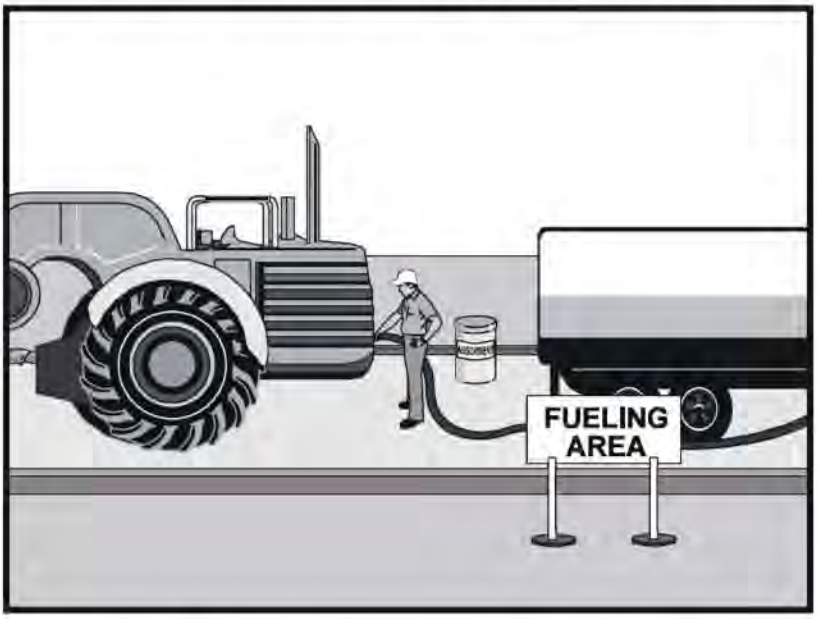
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should be disposed of properly after use.
- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

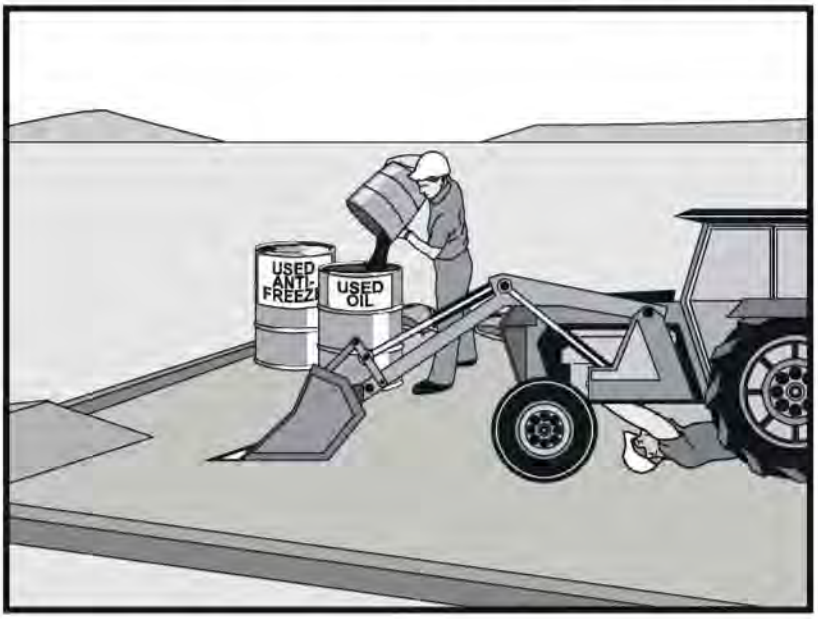
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TR-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

NS-10 Vehicle & Equipment Maintenance

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.
- Repair leaks of fluids and oil immediately.

Vehicle & Equipment Maintenance NS-10

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

NS-10 Vehicle & Equipment Maintenance

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

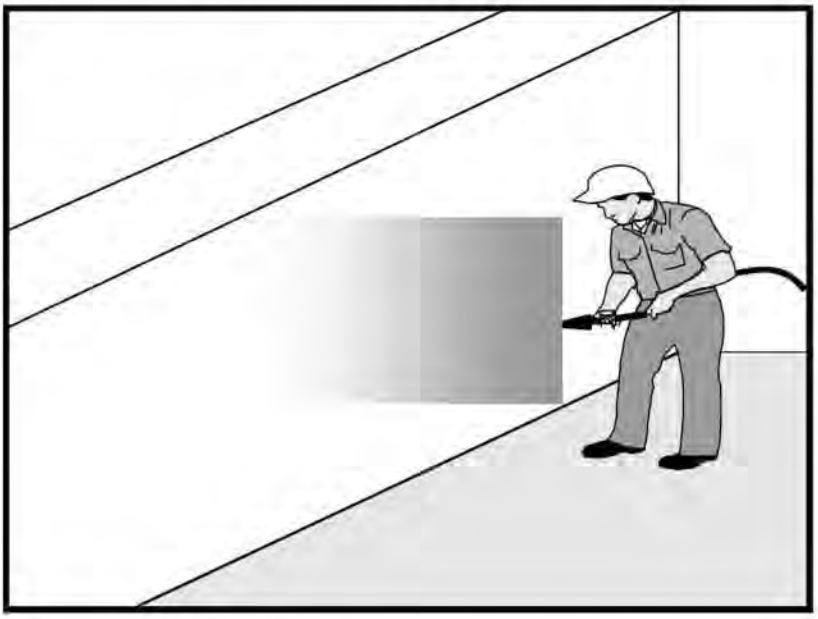
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Curing NS-12



Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. Proper procedures reduce or eliminate the contamination of stormwater runoff during concrete curing.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

None identified.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift of chemical cure as much as possible by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.

- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for infiltration or other means of removal in accordance with all applicable permits.
- Collect cure water at the top of slopes and transport or dispose of water in a non-erodible manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

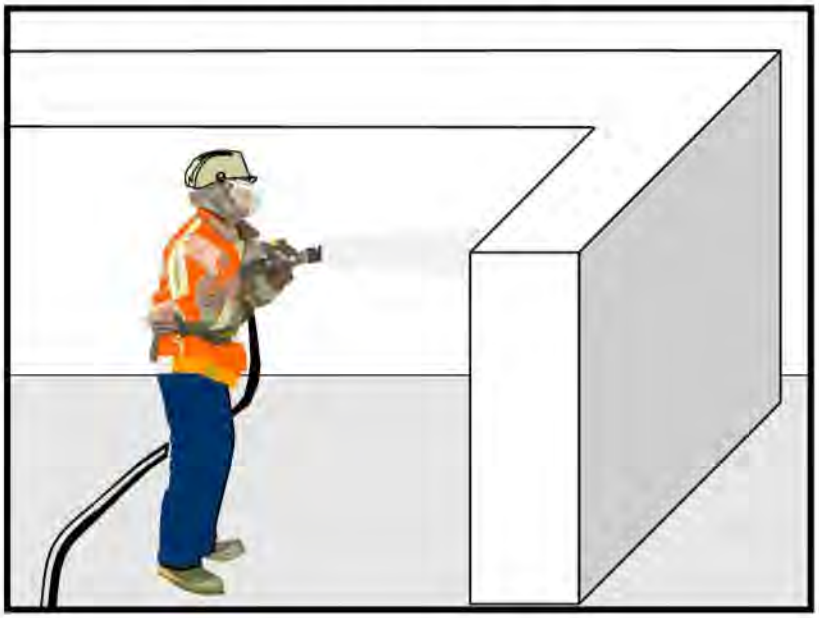
References

Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Concrete Finishing NS-13



Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

None identified.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.
- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.

Objectives

EC	Erosion Control	
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 De-Watering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete based debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Costs

These measures are generally of low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.

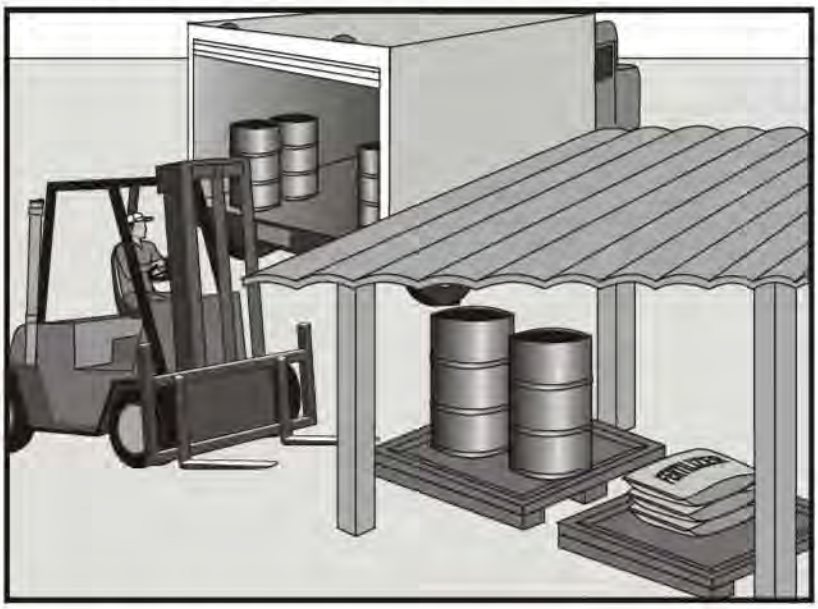
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Material Delivery and Storage WM-1



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease
- Asphalt and concrete components

- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Temporary storage area should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be supplied for all materials stored.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located near the construction entrances, away from waterways, if possible.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms. See EC-9, Earth Dikes and Drainage Swales.
  - Place in an area which will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.
- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- During the rainy season, consider storing materials in a covered area. Store materials in secondary containments such as earthen dike, horse trough, or even a children's wading pool for non-reactive materials such as detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in secondary containment.

- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids to reduce corrosion. Domed plastic covers are inexpensive and snap to the top of drums, preventing water from collecting.
- Chemicals should be kept in their original labeled containers.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, each temporary containment facility should be covered during non-working days, prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous materials.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Keep an ample supply of spill cleanup materials near the storage area.
- Keep storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References

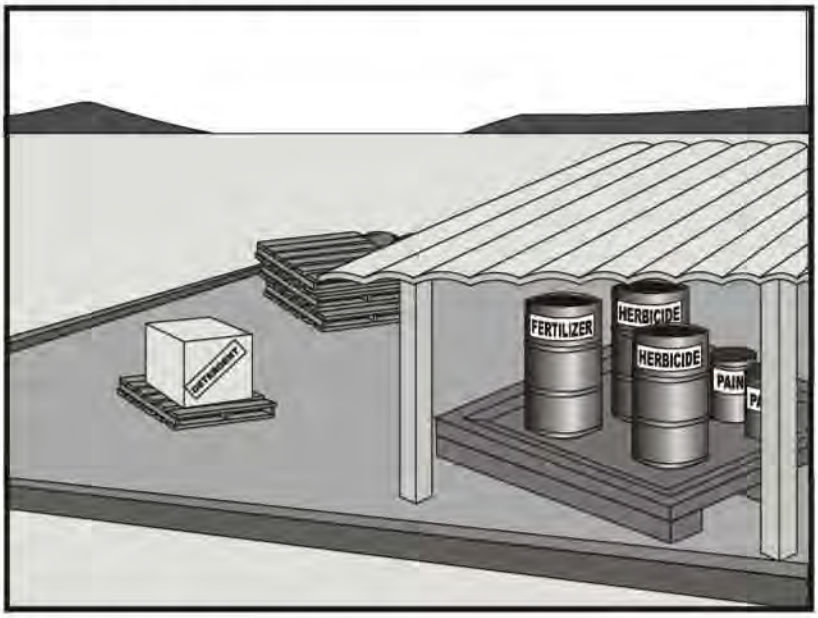
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Material Use WM-2



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydro seeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or into a concrete washout pit or temporary sediment trap. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.

- Require contractors to complete the "Report of Chemical Spray Forms" when spraying herbicides and pesticides.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and at two–week intervals in the non-rainy season to verify continued BMP implementation.
- Maintenance of this best management practice is minimal.
- Spot check employees and subcontractors throughout the job to ensure appropriate practices are being employed.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stockpile Management WM-3

Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile Management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other materials.

Limitations

None identified.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- Locate stockpiles a minimum of 50 ft away from concentrated flows of stormwater, drainage courses, and inlets.
- Protect all stockpiles from stormwater runon using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbag, gravel bags, or straw bale barriers.

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- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- During the rainy season, soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- During the non-rainy season, soil stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- During the rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier at all times.
- During the non-rainy season, the stockpiles should be covered or protected with a temporary perimeter sediment barrier prior to the onset of precipitation.

Stockpiles of "cold mix"

- During the rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material at all times.
- During the non-rainy season, cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Stockpiles/Storage of pressure treated wood with copper, chromium, and arsenic or ammonical, copper, zinc, and arsenate

- During the rainy season, treated wood should be covered with plastic or comparable material at all times.
- During the non-rainy season, treated wood should be covered with plastic or comparable material at all times and cold mix stockpiles should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected further as follows:

- All stockpiles should be protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" should be placed on and covered with plastic or comparable material prior to the onset of precipitation.

Costs

All of the above are low cost measures.

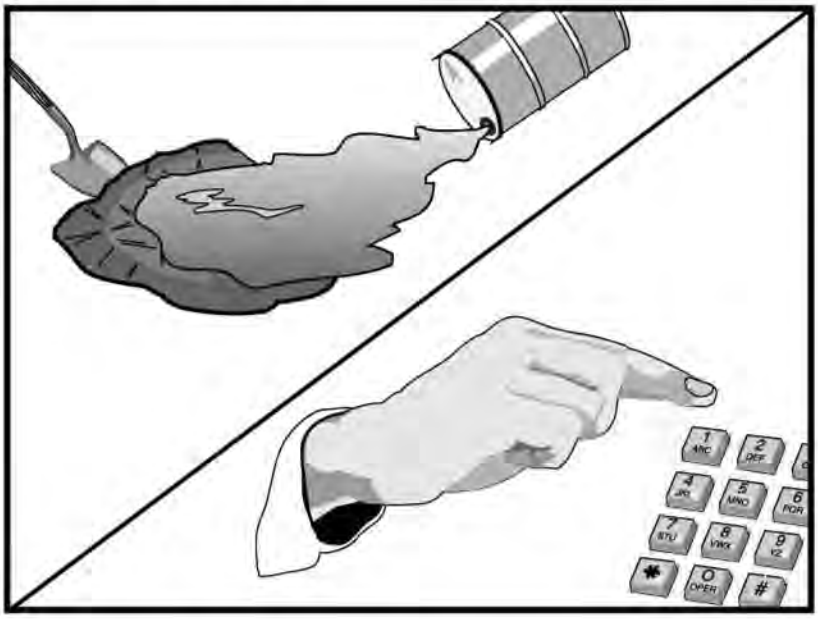
Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Spill Prevention and Control WM-4



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

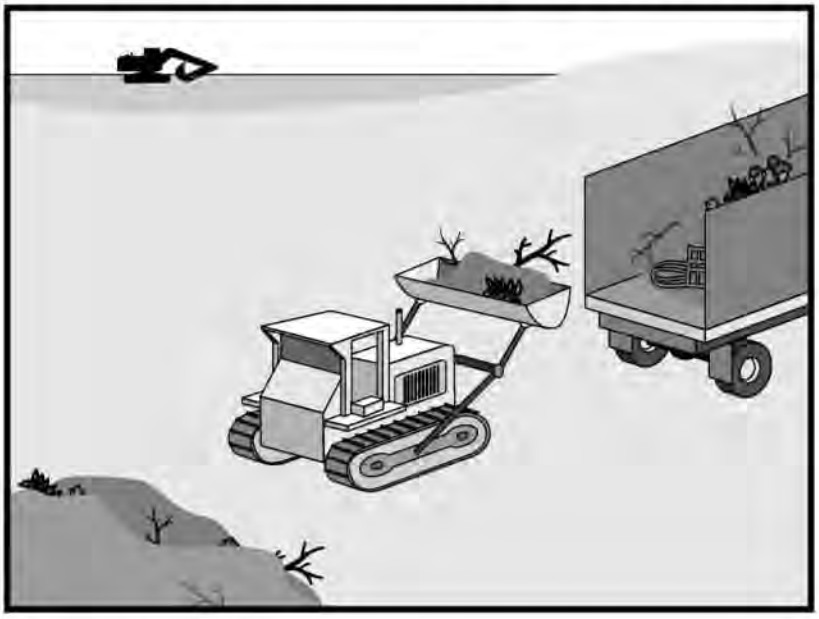
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Solid Waste Management WM-5



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials

- Highway planting wastes, including vegetative material, plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

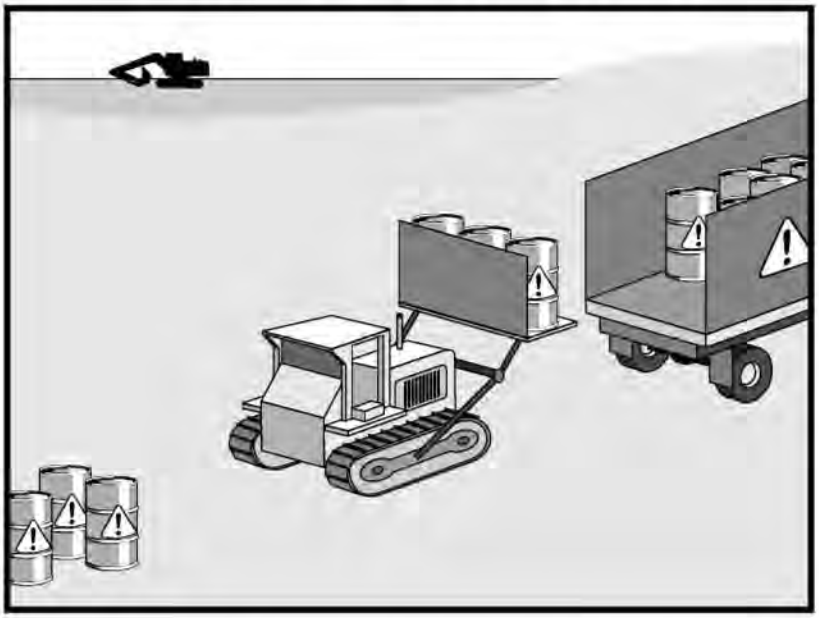
References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Hazardous Waste Management WM-6



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Septic Wastes
- Paints
- Stains
- Solvents
- Wood Preservatives
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.

- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.

- Unless watertight, containers of dry waste should be stored on pallets.

- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.

- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.

- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

- The following actions should be taken with respect to temporary contaminant:

  - Ensure that adequate hazardous waste storage volume is available.

  - Ensure that hazardous waste collection containers are conveniently located.

  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.

  - Minimize production or generation of hazardous materials and hazardous waste on the job site.

  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.

  - Segregate potentially hazardous waste from non-hazardous construction site debris.

  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.
- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.

- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References

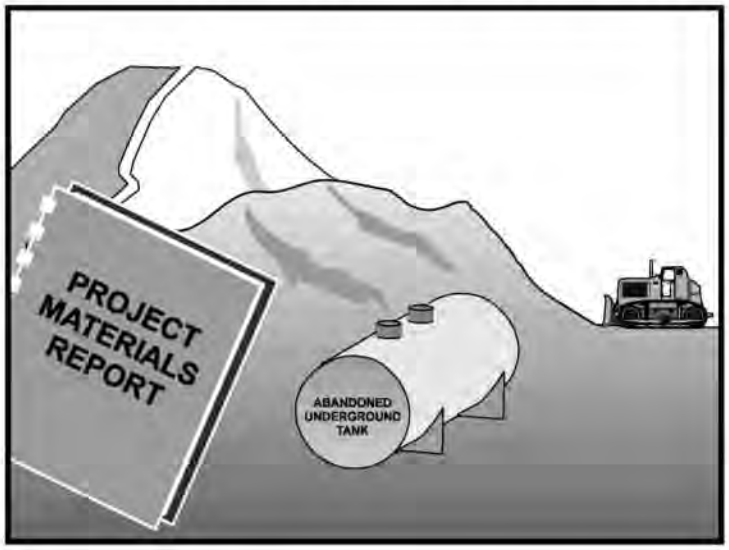
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Contaminated Soil Management WM-7



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the plans, specifications, and

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Concrete Waste Management WM-8

Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from concrete waste by conducting washout offsite, performing onsite washout in a designated area, and training employee and subcontractors.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result form demolition activities
- Slurries containing portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition
- Concrete trucks and other concrete-coated equipment are washed onsite
- Mortar-mixing stations exist
- See also NS-8, Vehicle and Equipment Cleaning

Limitations

- Offsite washout of concrete wastes may not always be possible.

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.
- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amounts of fresh concrete.
- Perform washout of concrete trucks offsite or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Wash out wastes into the temporary pit where the concrete can set, be broken up, and then disposed properly.
- Avoid creating runoff by draining water to a bermed or level area when washing concrete to remove fine particles and expose the aggregate.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.
- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility.
- A sign should be installed adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

- Below grade concrete washout facilities are typical. Above grade facilities are used if excavation is not practical.
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Saw-cut PCC slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.
- Slurry residue should be vacuumed and disposed in a temporary pit (as described in OnSite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.
- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and

minimum width of 10 ft, but with sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.

- Straw bales, wood stakes, and sandbag materials should conform to the provisions in SE-9, Straw Bale Barrier.

- Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- Temporary Concrete Washout Facility (Type Below Grade)

  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.

  - Lath and flagging should be commercial type.

  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of.

- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and disposed of.

- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

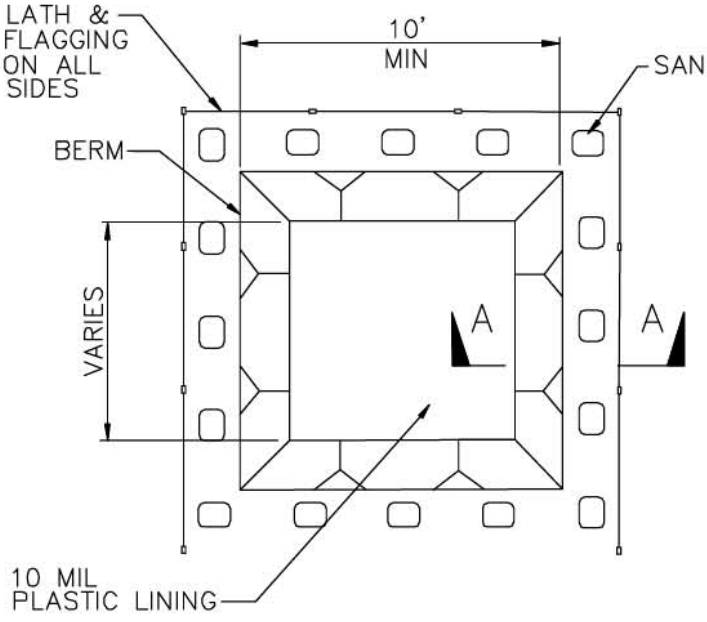
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

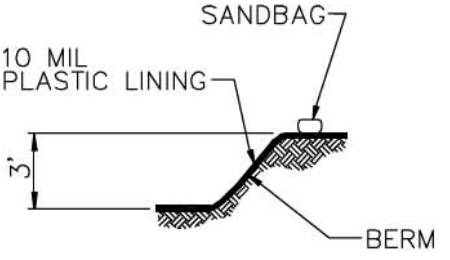
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

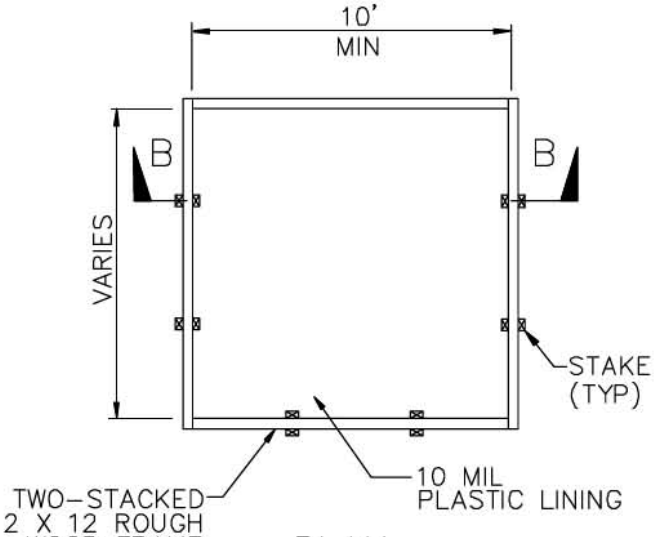
WM-8 Concrete Waste Management



PLAN
NOT TO SCALE
TYPE "BELOW GRADE"



SECTION A–A
NOT TO SCALE



PLAN
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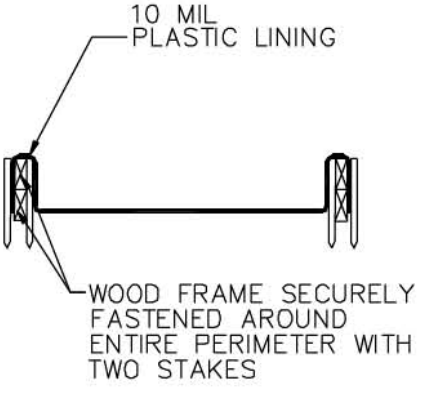
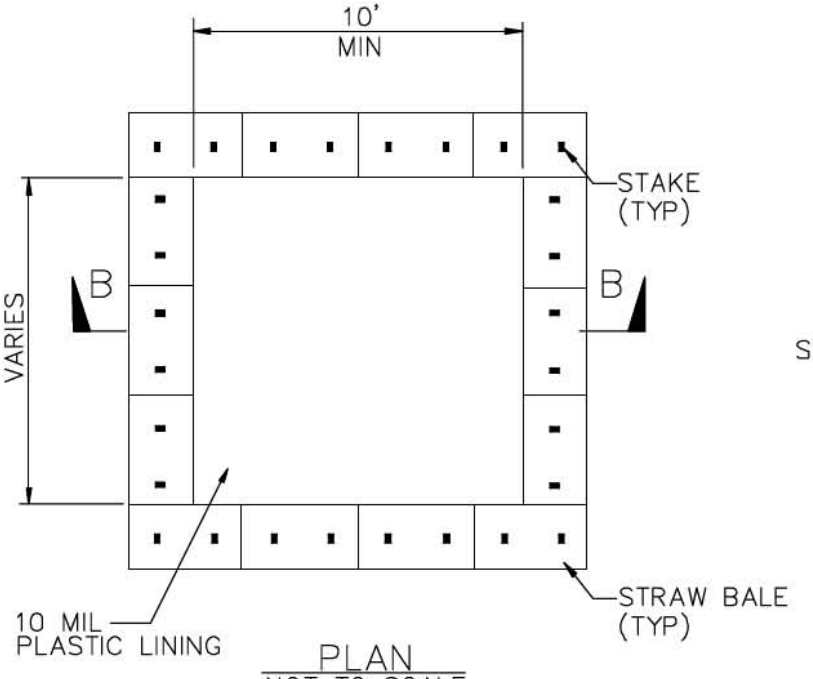
TYPE "ABOVE GRADE"



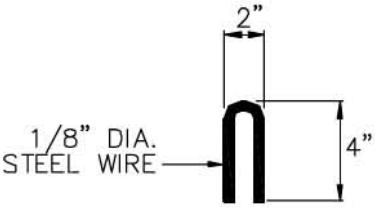
SECTION B–B
NOT TO SCALE

NOTES

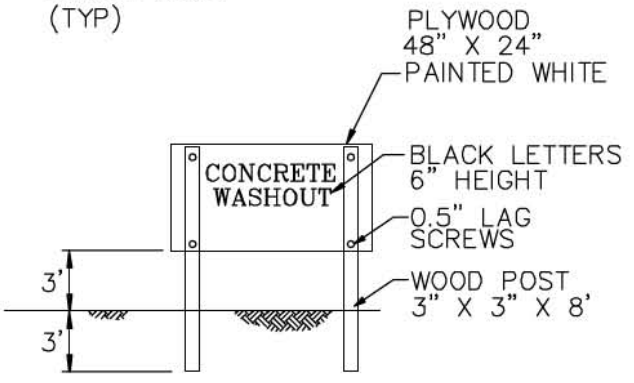
1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



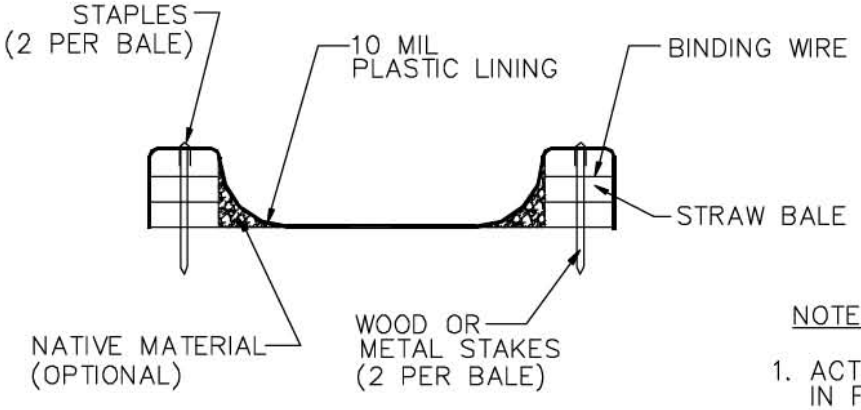
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"
WITH STRAW BALES



STAPLE DETAIL



CONCRETE WASHOUT
SIGN DETAIL
(OR EQUIVALENT)

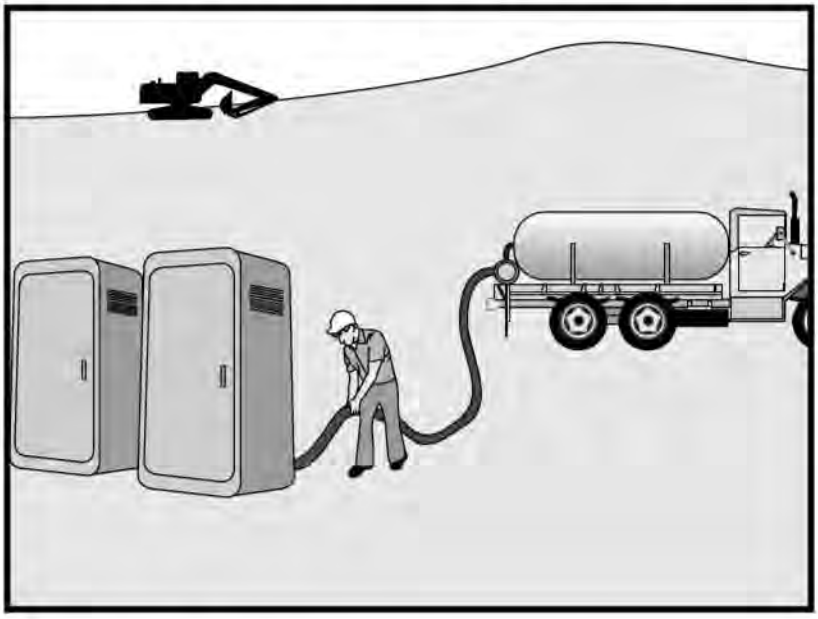


SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

Sanitary/Septic Waste Management WM-9



Objectives		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.
- Wastewater should not be discharged or buried within the project site.

WM-9 Sanitary/Septic Waste Management

- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Untreated raw wastewater should never be discharged or buried.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

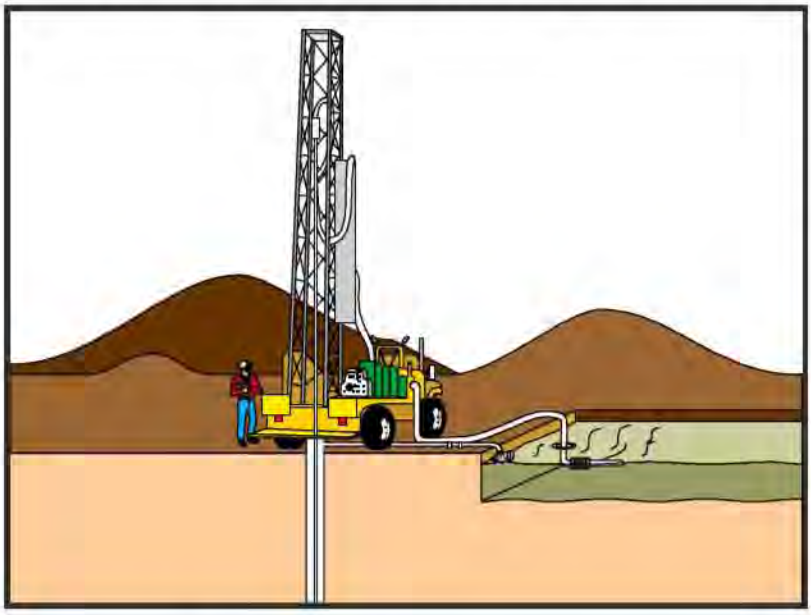
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Liquid Waste Management WM-10



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Liquid waste management includes procedures and practices to prevent discharge of pollutants to the storm drain system or to watercourses as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

Suitable Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous by-products, residuals, or wastes:

- Drilling slurries and drilling fluids
- Grease-free and oil-free wastewater and rinse water
- Dredgings
- Other non-stormwater liquid discharges not permitted by separate permits

Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations or to requirements of other permits secured for the construction project (e.g., NPDES permits, Army Corps permits, Coastal Commission permits, etc.).
- Liquid waste management does not apply to dewatering operations (NS-2 Dewatering Operations), solid waste management (WM-5, Solid Waste Management), hazardous

wastes (WM-6, Hazardous Waste Management), or concrete slurry residue (WM-8, Concrete Waste Management).

- Typical permitted non-stormwater discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and discharges or flows from emergency fire fighting activities.

Implementation

General Practices

- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.
- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage device, waterway, or receiving water.
- Educate employees and subcontractors on liquid waste generating activities and liquid waste storage and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Verify which non-stormwater discharges are permitted by the statewide NPDES permit; different regions might have different requirements not outlined in this permit.
- Apply NS-8, Vehicle and Equipment Cleaning for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of.
- If an appropriate location is available, drilling residue and drilling fluids that are exempt under Title 23, CCR § 2511(g) may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in WM-8, Concrete Waste Management.
- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.
- Liquid wastes should be contained in a controlled area such as a holding pit, sediment basin, roll-off bin, or portable tank.
- Containment devices must be structurally sound and leak free.
- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.

- Precautions should be taken to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in WM-4, Spill Prevention and Control.

- Containment areas or devices should not be located where accidental release of the contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes that have the potential to affect the storm drainage system (such as wash water and rinse water from cleaning walls or pavement), before they run off a surface.

- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.

- Use a sediment trap (SE-3, Sediment Trap) for capturing and treating sediment laden liquid waste or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- A typical method to handle liquid waste is to dewater the contained liquid waste, using procedures such as described in NS-2, Dewatering Operations, and SE-2, Sediment Basin, and dispose of resulting solids per WM-5, Solid Waste Management.

- Methods of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, Environmental Impact Reports, 401 or 404 permits, and local agency discharge permits, etc. Review the SWPPP to see if disposal methods are identified.

- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management.

- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

Costs

Prevention costs for liquid waste management are minimal. Costs increase if cleanup or fines are involved.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task. Dispose of any solids as described in WM-5, Solid Waste Management.
- Inspect containment areas and capturing devices and repair as needed.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

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APPLICATION FOR CERTIFICATION
FOR THE *IVANPAH SOLAR ELECTRIC GENERATING SYSTEM*

DOCKET NO. 07-AFC-5

PROOF OF SERVICE
(Revised 4/16/09)

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